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Rubber Research Scheme (Ceylon)

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FOREWORD

A RUBBER Conference on "New Planting and Replanting," organised by the Planters' Association of Ceylon, was held at the Grand Oriental Hotel, Colombo, on the 19th April, 1940. This was the second conference of its kind, the first having been organised in 1938 by the Kalutara Planters' Association and held at Tebuwana Club.

Arrangements were made by a Committee on which the Ceylon Estates Proprietary Association and the Rubber Research Scheme were represented, and these two bodies also contributed jointly with the Planters' Association towards the running costs.

The conference was opened by the Honourable Mr. D. S. Senanayake, Minister for Agriculture and Lands, and associated with him on the platform were Mr. P. B. Cruickshank, Chairman of the Conference Committee, Mr. R. C. Scott, Chairman of the Planters' Association, Mr. E. Rodrigo, Chairman of the Rubber Research Board, and Mr. R. K. S. Murray, Acting Director of the Rubber Research Scheme.

Eleven papers were given. These were printed in advance and copies sent to all those—some 300 in number—who had notified their intention of being present. The papers were not read in full at the conference, but a summary was given by each author as an introduction to the discussion. The papers and discussions are reproduced in this issue of the Quarterly Circular as a permanent record of the proceedings.

The conference was generally voted to be highly successful, and the fact that the morning attendance was not much less than 300 testifies to the interest shown by the industry and the suitability of the arrangements. If an editorial note of criticism may be permitted, it is to the effect that the value of the discussions would be greatly enhanced if a more representative proportion of the assembly were to give the benefit of their views and experiences.

Acknowledgment is made to "The Times of Ceylon" for permission to reproduce the photograph on the frontispiece.

RUBBER CONFERENCE HELD ON 19th APRIL, 1940

Mr. P. B. CRUICKSHANK
Chairman of Conference Committee

IN welcoming you all here this morning, I wish to touch very briefly on the short history of these Rubber Conferences.

You will recollect that the first Ceylon Rubber Conference was held in Kalutara in 1938, and was organised and financed by the Kalutara District Planters' Association, under the very able chairmanship of Mr. J. D. Farquharson.

Those of you who attended that conference will, I think, agree that not only was it a great success, but also that it showed us all the necessity for the constant revision of ideas and methods in the light of most up to date knowledge, if we are to retain our position in the world's Rubber industry.

From that conference naturally followed the question of future conferences. There are various obstacles to holding a conference at Dartonfield not the least of which is lack of a suitable conference room, and there was also a desire expressed in some quarters, that inasmuch as Members of the Planters' Association of Ceylon, had initiated the original conference, they should continue to organise future conferences.

Subsequently the Planters' Association of Ceylon elected a Committee with this object, and this explains, I hope, the heading to your Agenda Papers. I should, however, add that the Rubber Research Scheme of Ceylon and the Ceylon Estates Proprietary Association are represented on the Committee and that both these institutions have very generously offered to contribute towards the cost of the conference.

At the last conference the Chairman quoted you some acreage figures. I would like to quote some figures again to-day. At the end of 1938 the proportions of budded Rubber in the main producing countries, expressed as percentages of the total estate acreage, were as follows :—

Dutch East Indies...	30 per cent.
Malaya	12 „
Indo-China...	36 „
Ceylon	6 „

Those figures speak for themselves, but I would like to emphasise them, for the reason that with the present price of Rubber there is a tendency on the part of some proprietors to " take the cash in hand and leave the rest," " the rest " being routine replanting.

And now, Gentlemen, I wish to welcome on your behalf The Honourable, The Minister for Agriculture and Lands, who has come here to open our conference for us. In that Rubber is one of the largest Agricultural industries in the Island, I think you will agree that the Minister's presence here to-day is singularly appropriate.

I would also like on your behalf to extend a welcome to our other guests :—

The Chairman and Members of the Board, R.R.S.

The Chairman and Vice-Chairman, P.A. of Ceylon

The Chairman and Vice-Chairman, C.E.P.A.

The Chairman, L.C.P.A.

The Chairman and Vice-Chairman, Ceylon Chamber of Commerce

Mr. E. C. Villiers, M.S.C.

Mr. P. Saravanamuttu, Rubber Controller.

The Director and Officers, Tea Research Institute and

The Director and Officers, Coconut Research Scheme.

As time is limited, I hope, Sir, that you will forgive me if I content myself by saying how very glad we all are to see you here to-day, and by calling on you straight away to declare open the second Ceylon Rubber Conference.

The Hon'ble Mr. D. S. SENANAYAKE
Minister for Agriculture and Lands

I thank you very much indeed for the welcome you have given me. It is indeed a pleasure to me to be here to declare this conference open. When I received your invitation and when I received this book I realised that I should open this conference with as few words as possible. There are a number of papers, written by competent and experienced planters, and to delay you from discussing these papers will be a great disservice. But, before I sit down, I must congratulate the Planters' Association for organising this conference. There is no doubt that the first conference was a great success and, judging from the various papers before you for discussion, this second conference will be perhaps a greater success than its predecessor. Judging also from the number of people here it is apparent that you gentlemen appreciate the need for such conferences. I am sure we are all grateful to those who organised these conferences and for having made them so useful and interesting.

There was a time when we in Ceylon thought we were able to provide rubber cheaper than anyone else. We felt our soil was good and our labour satisfactory. We knew there was a keen demand for rubber, and prices were very good. Unfortunately times have changed. We find that there is more rubber in the world than is wanted by users. We also realise that prices are not as good as they used to be. We also realise that the Dutch during the last restriction period while we were trying to restrict, were forging ahead and planting large extents of land and were producing better planting material than us. Our problem to-day is that there is a potential over-production of rubber. We must do our best to organise ourselves to enable us to compete with the rest of the world. There was a time when we felt it was possible by cut-throat competition to knock the other producers out, but the whole world has realised that this is not possible or profitable now. We have now come to an agreement between all rubber-producing countries to produce only the quantity that is required at a price which we consider a fair one for the producer. It is necessary that we should find new uses for rubber and also produce rubber at lower costs than at present. We should also try to do our best

in this direction and we should try to improve our plantations by going in for replanting on modern lines. There is no doubt we would have to visualise the time when there will be a great deal of rubber on the market, and at that time if we do not expect ruin we should be able to produce that rubber at the cheapest possible cost.

Now the value of this conference is that we have an opportunity to pool the experience and knowledge of planters who have paid the greatest attention to the problem and I am sure we are all grateful to those who are willing to give their views on the methods that should be adopted to improve yields, to improve cultivation and to keep down costs. I feel that it is by joint effort that we will be able to achieve success.

I do not wish to detain you longer, but I wish to say not only as a Rubber planter myself, but as Minister for Agriculture, that the Rubber Industry is one the prosperity of which would contribute to the greater prosperity of Ceylon, and any gain that you would receive would accrue to the benefit of Ceylon. I wish your industry continued prosperity and I know there would be prosperity because there are such able men connected with the industry. I now declare this conference open.

REPLANTING—SLAUGHTER TAPPING EXPERIMENT

CARRIED OUT ON ELLAKANDE ESTATE, KALUTARA DISTRICT

C. GILLIAT
(Ellakande Estate)

1. Object

THE object of the experiment was to endeavour to discover a system of tapping for the wet zones during the 12 months immediately prior to felling for replanting, which would give the greatest quantity of latex in the most economical manner.

2. Site of Experiment

An area of 155½ acres was due to be felled, for replanting, commencing September, 1939. Of this area approximately 108 acres were utilized for this experiment.

Lie of Land.—The greater part of the area is a hillside not unduly steep facing N.E.

Soil.—Gravelly loam, kabooky in places, some rock, covered with a heavy growth of *Pueraria phaseoloides* planted in October-November, 1935.

Drains, etc.—The whole area was drained with the old-fashioned run-off drains one in thirty, 30 feet apart. It was also terraced with contour stone terracing.

Planting Distance.—Originally 24 × 15, but thinned out and also reduced by removal for disease during the past 30 years to an average stand of 72 per acre. The rows ran East and West across the face of the slope.

3. Previous History of the Area

Age of Trees.—Thirty-five years.

Bark Conditions.—The bark was on the thin side and with few exceptions the depth of bark in tapping did not exceed 7-8 mm. The panels were by no means smooth.

Cultivation.—The area was not manured between January, 1930, and January, 1936. Two hundred and fifty pounds per acre of the undermentioned mixture was forked in in January, 1936 :—

Sulphate of Ammonia	20 lbs.
Nitrate of Potash	10 „
Conc. Superphosphate	20 „
Saphos Phosphate	50 „
	100 lbs.

4. Tapping History

No. 8. 60 acres ... Double Four, 1933-1934—January, 1935. Rested March, 1935—March, 1938. One cut, half spiral alternate day, March, 1938—31st August, 1938.

No. 6. 55 acres ... Double Four, 1933-1934—January, 1935. One cut, half spiral alternate day, March-December, 1935.
Rested, 1936, 1937, January, February, 1938. One cut, half spiral alternate day, March—31st August, 1938.

No. 4. 44 acres ... Double Four, 1933-1934—January, 1935.
(only 5 acres utilized in the experiment) One cut, half spiral alternate day—March-December, 1935.
Rested March, 1936-1937—January, February, 1938. One cut, half spiral alternate day, March—31st August, 1938.

5. Treatments

After consultation with the Rubber Research Scheme (Ceylon) the following treatments were decided upon :—

A. (Control)—One cut half spiral alternate day. Six-monthly change over. Normal depth. Normal bark consumption.

B.—One cut half spiral alternate day. Six-monthly change over. Extra deep tapping. Unlimited bark consumption.

C.—One cut half spiral alternate day. Normal depth. Normal consumption. From commencement of experiment on 1st September, 1938, until resting period, followed by Double Two System extra deep tapping. Unlimited bark consumption.

D.—One cut half spiral alternate day. Extra deep tapping. Unlimited bark consumption. From the commencement of experiment on 1st September, 1938, until resting period, followed by Double Two System extra deep tapping. Unlimited bark consumption.

E.—Double Three System. No rest except for "Wintering" period. Normal Depth. Normal bark consumption.

F. Double Three System. No rest except for "Wintering" period. Extra deep tapping. Unlimited bark consumption.

G.—Double Three System. Normal depth. Normal bark consumption. No rest except for "Wintering" period after which Double Two System extra deep tapping. Unlimited bark consumption.

H.—Double Three System. Extra deep tapping. Unlimited bark consumption. No rest except for "Wintering" period after which Double Two System extra deep tapping. Unlimited bark consumption.

It may be asked why daily tapping and/or multiple cuts were excluded from the experiment.

In the first place one cannot hope to obtain data on every aspect of the subject in one experiment. Any attempt to do so would lead to confusion.

Secondly, when this experiment was planned the price of rubber and exportable quota were both very much lower than they are now. Therefore the cost of tapping was relatively more important.

6. Layout of Experiment

Each treatment was replicated **six** times. Each plot consisted of a tapper's task. In the case of the single cut systems the task chosen was 210 trees and for the double cut systems 105.

This is at once open to criticism on the grounds that the single cut tasks are too large and the double cut tasks too small, thus giving an advantage to the double cut systems so far as yield per acre and per tree is concerned. Whereas the single cut systems are favoured as regards yield per tapper. The reasons why this system was chosen were :—

(*a*) that in order to keep accurate figures in an experiment of this size carried out under estate conditions each plot had to be a tapper's task.

(*b*) that some single cut systems had to be changed to double cut systems for the second period and the only method of doing this without dislocating the layout was to divide the single cut tasks into two.

One replication of each of the eight treatments formed a block, the treatments being randomized in each of the **six** blocks. The existing rows were utilized. For example in Replication No. 1, Treatment A commenced at the end of the first row and continued up and down until 210 trees had been counted, Treatment E followed in the same way until 105 trees had been counted, and so on. Thin bark trees and dry trees were not included and were specially marked. This ensured that each replication of each treatment covered as much ground as possible and avoided the chance of any replications of any treatment being sited in a block of particularly favourable or unfavourable soil.

Each treatment was numbered, viz., A1-6 and had a distinguishing colour band. This band, the treatment letter and replication number were painted on the trees at the extremities of each tapping task.

The height of the tapping cut from the ground varied on every tree and depended entirely on where the tapping cut was at the time the experiment started. In no case was the height of a cut more than 27 inches from the ground.

In the double cut systems every effort was made not to have the cuts on each side of the tree at the same height and in the majority of cases this was avoided.

The average stand per acre over the whole area being about 70 trees the size of the single cut tasks can be computed at three acres and the double cut tasks at 1½ acres.

7. Tapping Arrangements

The felling of the trees in the area was due to commence on or about 1st September, 1939.

The usual six-monthly change over took place on 1st September, 1938, and this date was chosen for the commencement of the experiment.

As all men are employed on replanting work, all the tappers on the estate are women. Twenty of the best and most regular tappers were chosen. Eight more were added during the second period when treatments C, D, G, H became double cut systems. The tappers were moved from one treatment to another once every six weeks in order to minimise the variation due to differential skill of tappers.

In the case of sickness of a regular tapper, a reserve tapper, of whom three had been previously chosen, tapped the block.

8. Collecting and Yield Recording

Buckets were painted with the treatment colour and replication numbers, and were passed to each tapper in rotation.

The latex and scrap was measured in the usual way and entered against the tapper's name in ounces of dry rubber in a special check-roll. These weights were entered daily in a special book under the treatment and replication concerned. I shall be pleased to show the methods of recording to any members interested.

At the end of each month the yields were added up and calculated into pounds and the average per tapper was worked out for each replication of each treatment.

9. Statistics

The two periods into which the experiment was divided were :—

4th September, 1938, to 4th February, 1939, and

6th March, 1939, to 14th August, 1939.

It was unfortunate that two weeks' tapping in the second period had to be omitted, but felling could not be delayed any longer.

Table I gives the yields including scrap expressed as :—

(*a*) lbs. per tree.

(*b*) lbs. per acre.

(*c*) Percentage of A (control).

Table II gives the monthly yields (latex only) expressed as a percentage of A (control).

Table III gives the intake per tapper per day (latex only).

Table IV shows scrap as percentage of latex rubber for each treatment.

An analysis of the Tables brings out the following points :—

TABLE I

1. First five months. The randomized rows of trees making up treatment C appear by chance to contain rather lower yielding trees than those in the Control Treatment A. Otherwise the percentage of C would have been nearer 100 per cent. as both treatments were being tapped on the same system during this period. This is also noticeable when comparing C and D during the second period when both treatments were the same.

2. Comparing Treatments A and B for the whole period and C and D for the first five months there is an indication that on a half spiral on alternate days, extra deep tapping with unlimited bark consumption gives a small additional yield though the difference is not significant.

3. Comparing Treatments E and F for the whole period and G and H for the first five months, there is an indication that the extra depth and consumption causes a slight decrease in yield. This might be due to the ringing effect of extra depth on both sides of the tree. For the second period H is significantly lower than G, again suggesting the harmful effects of the extra deep tapping in the previous period.

4. Comparing E and G with A and C for the first period, the additional yield on the Double Three tapping does not differ significantly from the theoretical expectation of 33 per cent. It would, therefore, seem that the trees can " stand up " to this system for at least five months without showing any ill-effects.

   On continuing E into the second period after a month's rest, it shows a slightly decreased yield, but is still near the theoretical 33 per cent.

5. Comparing Treatments C and D with A in the second period, it would seem that Double Two tapping gives about an 80 per cent. increase for five months (after a month's rest). The comparison of treatment G with A shows that this is also the case after five months Double Three tapping, but H shows only a 56 per cent. increase after Double Three *deep* tapping.
6. The highest yield has been given by Treatment G (Double Three for five months followed by Double Two for five months after one month's rest). The yield per acre was 732.5 lbs., an increase of 51 per cent. over Control Treatment A (484.8 lbs. per acre).

TABLE II

1. *February.* There were only four days' tapping. The sudden drop in the yields from treatment A resulting in the somewhat abnormal increase in the percentages of the other treatments when compared to January is, I regret to say, inexplicable. But this has no material effect on the figures in general.
2. It will be noticed that there is very little decrease in yield on the Double Two treatment (plots C, D, G and H) towards the end of the 5-months period although the rubber content of the latex dropped from 3 lbs. 12 oz. per gallon of latex to 3 lbs. 2 oz. This suggests that Double Two tapping could profitably be continued for longer than five months.

TABLE III

It will be seen that Treatment E (Double Three normal tapping) throughout the two periods gave the highest intake per tapper, 9.7 lbs. The intake per tapper from Treatment G (the highest yielding treatment) was 8.6 lbs.

Had the tasks in the double cut systems been 130 trees instead of 105, the intake per tapper would have been even higher, but the gross yield per tree and per acre would have been somewhat lower owing to the extra length of time taken to tap the block.

TABLE IV

This table is given merely to show the percentages of scrap to latex rubber for each treatment. It will be seen that the differences are of little account. Only tree scrap and shell scrap were collected.

10. Conclusions

(*a*) *Rotation of Tappers.*—A careful scrutiny of the six-weekly records show the importance of this arrangement. There were two tappers whose results were interesting in that whatever treatment they tapped there was a slight decrease in yield.

(*b*) On single cut systems extra deep tapping and unlimited bark consumption gave a small additional yield, but of course had most detrimental results on renewal.

(*c*) On double cut systems extra deep tapping and unlimited bark consumption over the whole period resulted in a *decrease* in yield.

(*d*) That in this experiment the highest yield, which was the first object of the experiment, was obtained by Double Three normal tapping for five months followed by Double Two extra deep tapping for $5\frac{1}{4}$ months after one month's rest.

(*e*) That the cheapest tapping was obtained from the Double Three system throughout the period. If we take 50 cents per day as a tapper's pay as a convenient figure for these calculations, the cost of tapping (exclusive of kanganies and head money) would be 5.15 cents per lb. The cost of tapping from the highest yielding treatment (G) on the same basis would be 5.83 cents per lb.

(*f*) That the most economical system from a total cost of production point of view, was treatment G which gave 49 lbs. per acre more than any other system.

(*g*) With reference to paragraphs (*e*) and (*f*), the relative importance of the cost of tapping and the total crop depend on the price of rubber and the exportable quota. Under present conditions total crop is much more important than the cost of collection.

(*h*) That in general this experiment shows that trees can be tapped rather more severely than is generally thought.

Acknowledgments

My grateful thanks are due to the Rubber Research Scheme (Ceylon), particularly to Mr. R. K. S. Murray, the Botanist and Mycologist, whose assistance and advice have been invaluable.

I also wish to thank the Directors of the Rosehaugh (Ceylon) Rubber Company, Ltd., for permission to carry out the experiment.

SLAUGHTER TAPPING EXPERIMENT, ELLAKANDE ESTATE

TABLE I

Yields (including Scrap) expressed as :—
(*a*) lb. per tree. (*b*) lb. per acre. (*c*) Percentage of Treatment A.

Period	4/9/38-4/2/39			6/3/39-14/8/39			4/9/38-14/8/39		
Treatment	a	b	c	a	b	c	a	b	c
A ..	4·0	278·9	100·0	2·9	205·9	100·0	6·9	484·8	100·0
B ..	4·2	291·9	104·7	3·0	213·1	103·7	7·2	505·0	104·2
C ..	3·8	266·0	95·4	5·1	357·2	173·6	8·9	623·2	128·6
D ..	4·2	297·9	106·8	5·5	385·5	187·2	9·7	683·4	141·0
E ..	5·5	390·3	140·0	3·9	271·6	131·9	9·4	661·9	136·7
F ..	5·3	369·6	132·6	3·8	269·3	130·7	9·1	638·9	131·9
G ..	5·2	365·0	130·9	5·2	367·5	178·5	10·4	732·5	151·1
H ..	5·2	362·6	130·0	4·6	321·0	155·9	9·8	683·6	141·0

TABLE II

Yields (Latex only) expressed as percentage of A.

	A	B	C	D	E	F	G	H
September, 1938 ..	100	104·8	87·2	113·0	154·4	154·1	132·1	151·4
October „ ..	100	108·5	90·6	110·9	138·5	130·0	134·7	138·0
November „ ..	100	108·7	92·8	106·5	146·1	133·6	134·9	136·0
December „ ..	100	102·2	99·9	99·3	135·2	118·7	131·5	116·9
January, 1939 ..	100	97·1	101·9	109·1	133·7	136·2	121·9	112·0
February „ ..	100	114·1	108·2	123·5	136·5	171·8	127·1	141·2
March „ ..	100	103·9	177·6	187·6	117·1	123·1	174·2	154·9
April „ ..	100	100·5	161·9	172·1	118·0	124·4	158·9	133·7
May „ ..	100	100·6	174·0	189·4	117·1	142·9	184·6	153·0
June „ ..	100	101·6	174·8	185·7	139·6	131·0	192·9	168·0
July „ ..	100	114·7	193·1	205·8	162·2	140·7	200·7	186·9
August „ ..	100	100·0	155·1	200·7	150·7	117·8	160·3	154·1

TABLE III

Intake per Tapper as Expressed in lbs. of Dry Rubber (exclusive of Scrap)

Period	4/9/38 to 4/2/39	6/3/39 to 14/8/39	4/9/38 to 14/8/39	
Treatment				
A ..	10·8	8·0	9·4	
B ..	11·3	8·2	9·8	
C ..	10·3	6·9	8·0	
D ..	11·7	7·4	8·9	
E ..	11·4	7·9	9·7	Highest intake per tapper.
F ..	10·8	7·8	9·3	
G ..	10·7	7·1	8·6	
H ..	10·6	6·2	8·0	

TABLE IV

Intake of Scrap Rubber Shown as Percentage of Latex Rubber.

	Per cent.
Tretment A	8·3
„ B	8·3
„ C	9·1
„ D	8·2
„ E	8·0
„ F	7·9
„ G	8·2
„ H	8·1

Discussion

Mr. R. C. L. Notley.—In regard to the information on pages 46 and 47, may I ask why the double-three system was included for 12 months in these experiments ?

Mr. Gilliat.—The answer to my mind is three-fold. There was no proof that the most drastic system after a period of 12 months would give the highest yield. It was possible that a semi-drastic system would give a higher yield—actually it gave 661·9 lbs. per acre.

Secondly, so far as was known there were no figures available at that time showing the results of this system over a long period.

Thirdly, tapping was done right through without any rest except during " wintering." It was felt that it would be interesting to compare these figures with the " control " system.

Mr. G. B. Foote.—May I ask why you did not resort to daily tapping, and why a month's rest was included ?

Mr. Gilliat.—Dealing with the first part of the question, I wil say that it is not possible in one experiment to include every system that we can think of. It would complicate the experiment and make it unwieldy. It was very large as it was. Taking the age of the trees into consideration, it was felt that the trees would not stand up to such a drastic system for twelve months.

With regard to the second part of the question, machinery had to be overhauled and there was no means of making rubber, so that the whole estate had to be closed down.

Mr. A. H. Healey.—Can you step outside the scope of this experiment and give us information with regard to a longer system—extending over a period of, say, four years ?

Mr. Gilliat.—I am afraid I have not worked anything out like that. The danger in long-term slaughter tapping is the possibility that a change in the price of rubber and other upsets might cause Directors of Companies suddenly to stop everything. If you have, say, 50 acres on a slaughter tapping system and you have mucked it up you have ruined it for sometime.

Mr. J. D. Farquharson.—In the event of a long-term policy being adhered to which of your systems would you advocate ?

Mr. Gilliat.—I would suggest System " G "—double-three, normal depth, normal bark consumption, no rest except for wintering period. The only damage you would have done is to take off extra bark. The result of this experiment, as far as it went, rather showed that trees would stand up to severe systems for a longer period than we had hitherto thought. Table I, in the second column under the heading F, will show that yields per tree had dropped from 5·3 to 3·8, but it was still going strong at the end of the year.

Mr. G. B. Foote.—Can you tell us whether these blocks had been well cultivated before the experiment or whether they suffered from lack of cultivation for a period?

Mr. Gilliat drew attention to the information given in section 3 of his paper and said that one of the objects of the fertiliser application was to assist cover crops.

Mr. Farquharson.—May I ask whether you took into account weather conditions? During the period was there a severe drought? I do not know what you found in the various blocks, but it would be of interest to know whether these conditions would apply equally to the dry mid-country.

Mr. Gilliat.—In the opening paragraph of my paper I say that the object of the experiment was to endeavour to discover a system of tapping for the wet zone during the twelve months immediately prior to felling for replanting which would give the greatest quantity of latex in the most economical manner. I am not competent to speak in regard to the dry zone.

Mr. Farquharson.—Had you any results in January to suggest a drop in the dry months?

Mr. Gilliat.—No, I must say I did not notice any peculiarities with regard to these systems during January to March, as compared with the remainder of the estate. The yields from the heavier tapping systems did not drop during the drought experienced in 1939. There was a very fine canopy of Pueraria and the overhead canopy was not at all bad.

Mr. E. T. Fernando.—May I enquire from Mr. Gilliat what the reaction of the tappers was when they finished this tapping and when they were detailed to do other tapping?

Mr. Gilliat.—Tappers were rotated every six weeks and after six weeks they were given new tapping. Some of them are still slaughter tapping—when they finish they will be given other tapping. I have had no trouble at all.

Mr. J. C. Mitchell.—You make no mention in your statistics as regards the actual yield per tapped cut. I have worked this out myself. The biggest yield per cut is on the A and B systems which was 3·07 and 3·20 respectively. Next to that comes E and F. These figures are quite important and interesting if you are going

on to two years tapping. The double-three which gave a high yield would probably be the least over two years.

Mr. Gilliat.—I quite agree—I have not worked out the figures myself. It is a definite point which should be included in the records.

Mr. E. C. K. Minor.—Did you notice anything in regard to Brown Bast in your experiments ?

Mr. Gilliat replied that he did not find anything that was of interest.

Mr. G. P. N. de Silva.—Is not the cost of tapping very high ?

Mr. Gilliat.—I have taken 50 cents a day for a man or woman, and I do not think it is over present day wages—of course, this includes the Head Kangany's head money. I think it is quite fair.

Mr. T. C. A. de Soysa.—With regard to the figures in Table I, I would like to know whether these have been worked out statistically so as to indicate the significance of the differences.

Mr. Gilliat.—The figures in my paper were not worked out by myself, but the Rubber Research Scheme. Perhaps Mr. Murray, the Botanist and Mycologist of the Rubber Research Scheme, whose assistance and advice in preparing this paper I must acknowledge, will give the necessary reply to the very important point raised.

Mr. R. K. S. Murray.—The Committee has asked me to undertake the rather difficult task of attempting to sum up very briefly the salient facts and trend of opinion emerging from the discussion on each paper—or at least each paper on which I feel at all competent to speak. I suppose the privilege of having the last word in any discussion should be regarded as a big tactical advantage and I hope I shall not abuse this privilege by giving you a review which is heavily biased by my own opinions. Not that I relinquish the right to make observations which express the official views of the Rubber Research Scheme, but I want to avoid confusing them with what I take to be the majority opinion in the room, which may not be quite the same thing.

Turning to this particular paper, the discussion has naturally turned on the choice of tapping systems and I think there is a feeling, perhaps a critical feeling, that the systems chosen were hardly severe enough. I must accept my share of responsibility because the

treatments were decided upon between Mr. Gilliat and myself. Mr. Gilliat has given you excellent reasons for the choice, and I might add that they were selected to fit in with such information as we had from other experiments, particularly two that were carried out on the Experiment Station at Peradeniya, in 1929 and 1931. These experiments showed that the main factor in cuts going dry was the frequency of tapping and not so much the number of cuts. The conclusion reached was that it was better to increase the number of cuts rather than reduce the interval to one day. It is possible that the results of Mr. Gilliat's experiment were influenced by the fact that the fields had been rested for three years prior—though not immediately prior—to the commencement. This might have enabled the trees to stand up to these severe systems rather better than they would have done had they not been so rested.

The question was asked as to what tapping system would be most suitable for a long period and I support Mr. Gilliat's reply. In an experiment on Dartonfield Estate trees tapped on the double-three systems without rest, except for wintering, have shown no signs of reduction in either yield or dry Rubber content after two years. The point has been raised that if there is a change of policy and a particular area is not to be replanted the trees might have suffered permanent harm. My opinion is that on the double-three system the trees would have suffered no harm except for a slight increase in Brown Bast and the consumption of more bark than usual. As regards the last question on the statistical significance of the results, I have not got my figures with me, but my recollection is that a difference of more than about 10 % could be regarded as significant by the conventional criterion of a 20 : 1 chance. Thus all treatments from C to H gave a significantly higher yield than A or B.

In concluding my remarks I would say that although the experiment was not designed to compare all the possible methods of severe tapping I think you will agree that the results are of value. I hope estates will carry out further experiments with our help. Slaughter tapping experiments cannot easily be carried out on Dartonfield since the area necessary is more than we wish to replant in any one year. Perhaps Mr. Gilliat with his well-known efficiency and energy may be persuaded to carry out further experiments.

MODERN METHODS OF OPENING JUNGLE FOR RUBBER

FRANCIS DE SARAM
(Gasnawa Estate)

PART I

THE baby of our staple products is undergoing perhaps the most rapid and radical changes in its evolution that any staple product has yet been called upon to survive. For this very reason some service could be obtained from the radical minded, and it is in this belief that I have been encouraged to accept a flattering invitation to give expression to my views.

A most important phase of this evolution is the preparation of land for New Planting—on it depends the success or failure of the whole venture—the maintaining of our industry on a world competitive basis—the very life span of our highly productive and therefore less hardy selected material.

Selection of Land

For want of space, it must be taken for granted that the selection has been made after the careful consideration of climatic conditions, rainfall, elevation, lie of land, soil, fertility, natural drainage and accessibility, and, finally, after obtaining the scientific opinion of a soil expert.

Selection of Building Sites

If the area justifies erection of buildings, expert advice should be obtained regarding this and the question of malaria control and water supply well considered. Line colonies are now more popular than the erection of scattered buildings.

Denudation or the Clearing of Jungle Prior to Undertaking Earth Works

Under methods hitherto recognised it is important to obtain a good burn, which places the best period for felling at December

—or even earlier if dealing with heavy forest, in order to obtain a satisfactory burn during the February dry weather. If stumping is not contemplated it is important that trees should be felled as near ground level as practicable.

It is doubtful whether stumping is justifiable. I tried it out when opening a steep and rocky chena land—it certainly adds to the appearance of a clearing, and simplifies and slightly cheapens earth works and subsequent weeding rounds, but it greatly disturbs surface soil, increasing the risk of wash. I have not had the opportunity of trying out this work when dealing with forest.

Cultivation or Earth Works

It is here that the greatest differences in opinion are to be found, but with minor modifications, the recognised methods may be classified under three main sub-heads: (1) Contour Platforms, (2) Contour Trench Planting, (3) Ordinary holing, with bunded drains, possibly supplemented by independent silt-pits.

It is not proposed to elaborate on these, as this ground has already been ably covered by various writers. Neither is it proposed to discuss the merits of any one system as compared with another, as it is felt that the actual method selected should be made to depend on physical conditions rather than on any personal bias, for reasons given later.

Whatever the method selected lining and holing should be done on the contour in such a manner as to give an average initial stand of between 140 and 150 trees an acre, and there are not many planters left to-day, who are opposed to this principle.

Holes should not be less than $2\frac{1}{2}$ by $2\frac{1}{2}$ and preferably 3 by 3 ft. It is well-known that holes must be filled with top-soil and ashes. It is probably equally well-known, though not so well advertised, how easy it is to get into difficulties over this, particularly with the larger holes it is customary to cut these days. Elaborate earth works often complicate matters and the keenest vigilance is called for.

Terracing

Building stone terraces has certain disadvantages, and should only be resorted to where conditions make other earth works impracticable. These should only be looked upon as supplementary

to cover crops. Lower and more frequent terraces will minimize erosion, which is caused by cascading water displacing soil particles at the base of the terrace.

This is best achieved by carefully following the natural contours of the land as far as possible, and by keeping the surface of the terrace dead level.

Cover Crops

The selection of covers is another matter over which opinions differ, but with such a formidable list from which to make a choice, unanimity would be too much to expect at this stage. Latest field experiments made by the Rubber Research Scheme reveal that the best results were obtained in the long run, in clearings under *Pueraria javanica*.

Rainfall, however, is a very important factor. I have seen budded rubber showing excellent growth and vigour under a heavy cover of *Pueraria javanica* with an annual rainfall of over 150 inches, while buddings often appear yellow and starved under a similar cover where rainfall is more like 100 inches or less. The latter conditions probably call for quite different treatment, *i.e.*, the slashing down or turning in of covers just before a drought, to break up capillary action and prevent excess loss of moisture by transpiration.

Experience has shown that no soil is likely to support any one cover indefinitely, and as the degree of success of individual varieties varies with local conditions, it would probably be best to try out a few of the better recommended varieties, and decide on establishing at least two as a safeguard against staleness or " cover sickness."

Desmodium ovalifolium seems an ideal cover for young rubber, combining as it does the advantages of both the creeping and bushy varieties. It is felt that the greater the mixture of covers the better for the soil, as different varieties feed in and improve different soil layers, but this would not suit the aesthetic sense of some of our visitors and so some sort of order had best be preserved.

Water Table and Soil Moisture

Though not frequently dealt with, this is a vitally important item. As in the case of temperature, seasonable changes within limits, in the height of the water table are desirable and stimulate

soil aeration. Water movement plays an essential part in soil "breathing," and the lack of it, as in water-logged areas, is often the limiting factor regarding the rate at which trees can assimilate nutrients, regardless of any quantity of manure applied. Desperate efforts are sometimes made, especially by small-holders to overcome the difficulty by cutting deep trenches without regard to an outlet, with the result that these remain half full of water most of the time and the position is not improved. On the other hand, an equally detrimental state of affairs can be created by cutting trenches too deep where there is an outlet, as this merely leads to the overlowering of the water-table, and the consequent draining away of soil-water containing salts vital to soil life.

A possible solution well worth exploring when dealing with an area which is waterlogged or where the water-table is too high is to have two sets of alternating trenches, the one set lower than the other, providing of course that the lie of the land lends itself to the treatment, and there is an eventual outlet for the lower set of trenches. This should stimulate water movement, enabling roots of trees to function normally, and soil to release unwanted gases and draw in fresh air containing the oxygen necessary for the proper functioning of the micro-organisms.

Again, the cutting of silt-pits in deep drains on over-porous quartzy hillsides may well lead to the leaching of the particular soil zone, in which the major portion of the rubber feeder roots are to operate, when valuable plant-food may be permanently lost to the tree through sub-soil drainage.

To over work light sandy soils may lead to the loss or damage of valuable colloidal material, necessary for improving crumb formation, water retaining capacity and general tilth, while the lack of cultivation in heavy clays may tend to increase the amount of water permanently held by colloidal clay, and therefore lost to living things.

Here then is a brief sketch setting out a few salient, though perhaps not the most obvious reasons why the method of earth work selected should depend on physical conditions.

PART 2 (NEWER PLANTING METHODS)

I have for some time been opposed in principle to the customary burn on the following grounds :—

(1) We destroy in one good burn a natural wealth of potential humus and nitrogen, which we spend a life-time in trying to replace.

(2) Although phosphates and potash are returned to the soil in a form more easily assimilated by the young rubber, it is questionable as to how long this remains available, and how much is actually taken up by the plants before it is lost.

(3) The stupidity of exposing land, even for a short time, to the known destructive effect of direct tropical sun and rain.

To suggest a practical alternative, however, is quite a different matter, and is something that I am as much in search of as anyone else.

I have not been able to obtain data of the actual loss in nitrogen caused by a burn on either chena or forest, but Dr. Whelan, our Soil Chemist, has very kindly supplied me with the following figures obtained from Malaya, which though referring to a rubber clearing and not to jungle are nevertheless significant and interesting :—

> " A rubber tree, 10 to 12 years old, 60 feet high and of 29 inches girth and weighing 11,700 lbs. was found on analysis to contain 34 lbs. nitrogen, 11 lbs. phosphoric acid, 39 lbs. potash, 58 lbs. lime and 15 lbs. magnesium oxide. The nitrogen contained in a stand of 100 such trees to the acre would be 3,400 lbs. equivalent to 7½ tons (approximately) of sulphate of ammonia."

Assuming that the greater part of this nitrogen is lost in the gaseous form on burning, the question as to whether vegetation could not be more profitably disposed of becomes of paramount importance.

A few years ago I suggested contour avenue planting as a possible solution, *i.e.*, adjacent parallel lines of rubber 10 feet apart —plants 11 feet along contour and avenues 45 feet apart—leaving a broad belt for jungle (=ordinary planting 11 by 27½ ft. giving 144 trees per acre).

On a clearing planted on this principle (where in practice I only worked in 130 trees per acre) the growth so far appears to be about the same as under orthodox planting, but it is too early to make any claim as to the success or failure of this method as there

has not yet been time for jungle to compete with rubber for food, or for young rubber plants to feel any ill-effects from overshadowing each other. Foliage is healthy which is generally a sign that there is nothing much wrong.

It is now learnt that several modified and interesting methods are being tried out in the Straits, and results will no doubt be carefully recorded as time goes on. These are dealt with in detail by Mr. A. T. Edgar in his " Manual of Rubber Planting (Malaya)," and may be summarised as under :—

Method A.—The jungle is felled, and a light burn is obtained by firing from two to three weeks after felling before timber is fully dry. The lighter debris is piled on the heavier timber to minimize the heating of surface soil during the burn.

Contour lines are then worked in at intervals of 22 ft. —paths cleared of timber, which is laid between lines to decay, and holes cut for planting, at 11-foot intervals which on hillsides is done on platforms.

Method B.—Similar to A, except that no burning is done at all.

Method C.—Only considered workable where partial deforestation has already taken place or where land is under secondary growth. Six to eight feet rentices are cleared along the lines—the remaining standing timber is then felled so as to fall between these cleared paths. Work then proceeds, no burn having taken place.

Apart from saving direct losses from a burn all these schemes aim at preventing soil temperature from rising above that obtaining under forest, so that humus can continue to be produced at a rate greater than it is exhausted. To permit a rise in temperature leads to rapid decomposition of soil organic matter and a further loss of nitrogen.

I have observed that where controlled secondary jungle has been permitted from time of planting, earth-worm activity continues markedly in evidence, after a vigorous cover like *Pueraria phaseoloides* has been permitted to replace such growth in the 7th to 8th year. By this time the undergrowth is usually restricted by the increasing shade of rubber, and may be considered to have done its job.

We may even have to forgive a slower initial growth of rubber under fuller soil protective methods, rather than remain pleased

with the forced growth in earlier years resulting from original clean clearing, if the latter process leads to the upsetting of soil equilibrium, which is to take its toll from rubber in after years.

On the basis that rubber is a jungle tree, and therefore inherits a certain degree of " tolerance" in the forestry sense of the word (as is seen from the foliage of low branches on many trees in spite of a dense canopy of leaves overhead) the possibility of being able to adopt some form of " Shelter-wood " felling, under the protection of which earth works could be carried out, and rubber successfully established is well worthy of thought and trial, and may open up a new field for investigation.

We vie with each other regarding the most elaborate and attractive earth works that should be employed, but where, might I ask, are the platforms, trenches or even drains in the forest, where, before man commences his destruction or denudation, soil structure and fertility are far nearer perfection than anything we can produce.

This is why I question the recognised or so-called orthodox methods of preparing land for planting. We are still in the experimental stage and what is required is some practical method by which we can profit by the invaluable knowledge passed on to us by the painstaking students of research, without unduly complicating work to be handled by unskilled labour.

MODERN METHODS OF OPENING JUNGLE FOR RUBBER

R. I. M. GWYNN
(Kitulwitigala Estate)

UNFORTUNATELY during the past ten years very few of us in Ceylon have been able to get any experience in opening up jungle or to try out any experiments in this line, and although rejuvenation of old rubber has assisted us to determine what are the most suitable method *re* lining, holing, and treatment of the stumps after planting, this does not help in deciding the actual method of planting jungle, as in the case of rejuvenation most of our experiments have been to try and remake an exhausted and washed out soil, while in the case of jungle planting we have to determine the best method of conserving, and, if necessary, improving the excellent humus and top soil we have already awaiting us.

Undoubtedly the best method which will ensure wasting as little as possible of the natural reserves of the land is that of planting without burning and this has been extensively tried out in the Straits and very favourably reported on by the Rubber Research Institute of Malaya, and I cannot do better than quote from their introduction in their September Bulletin. "The advantages of planting without burning are many, the top soil and particularly the humus are conserved, the surface soil is kept microbiologically alive instead of being temporarily sterilized by fire and more of the plant-foods stored in the jungle plants are saved, natural covers get a good start, and so on. The disadvantages have still to be studied thoroughly but none appear to be overwhelmingly serious."

The method which can be recommended consists of first clearing contour strips 6 ft. wide in the standing jungle, approximately 20 ft. apart, the standing trees are then felled so that they fall along

the side of the hill, or between the contour strips, as they can then be easily moved to lie along the contour in the uncleared land; branches, etc., will have to be lopped off as it is most important that the large trunks should lie as flush as possible with the ground to ensure that there shall be no surface wash under them as after the rest of the debris has been piled up over the trunks, it is very difficult to check off if there is a soil wash; it will be found that constant supervision is required in the early stages as in practice it is often found extremely difficult to get all the trunks to lie close on the ground and a certain amount of the usual soil erosion methods at some points may be necessary.

All large stumps should be removed from the cleared contours and they and the other litter should be piled up on top of the tree trunks after the remaining undergrowth has been pruned down, and these should all be pressed down as far as possible so that they may rot more easily, and lose the least amount of nitrogen possible; it naturally follows that the ground in this space is kept shaded and moist, and this will greatly assist the germination and growth of the natural cover, which should be allowed to grow up and which should be found to develop freely under these conditions.

The contour lines of holes, say 15 ft. apart, can then be cut along the cleared rentices and plenty of good jungle soil should be available for filling these; the distance apart along the contours is, of course, governed by the stand of trees required.

I would recommend cutting a 3 ft. path or platform between the holes. Holing should be done in the usual way though it may not be necessary to cut such a large hole as one has to in poorer rejuvenated areas and a hole $2\frac{1}{2}$ ft. deep by 2 ft. wide will probably be sufficient. One advantage of this method is that it is possible to plant up the area in practically the same month it is felled as one's holing and filling gangs can follow up closely behind the fellers and pilers, and the long period of waiting for a burn is abolished and this would be of great assistance in cases where it can only be decided at short notice to open up land. The 6 ft. contour can be kept clean weeded or a certain amount of natural cover could be allowed to grow up, although the 3 ft. path must always be kept clean and the control of the uncleared area will be easier to supervise if the whole of the 6 ft. belt is clean weeded. No planting of

leguminous creepers should be allowed, and natural thick growing creepers such as Mikania must be kept out of the piled up spaces, as either of these are not only unnecessary but are positively harmful in so much as they will probably strangle out many of the best forms of natural cover plants, some of which are rather slow in coming away, and later on when the creepers have died out the soil will be insufficiently protected against erosion; also if the litter between is covered with thick creepers it makes it doubly difficult to check off if there is an underwash at any particular point. Weeding cost should be low, as it is only necessary to keep the cleared spaces weeded, to remove undesirable types of plants from the remainder and to prune down the cover when required. The height to which the natural cover must be pruned will depend on the height of the pile of logs and litter, but will probably vary from 3 ft. to 6 ft. after some of the pile has rotted off. In later stages when the logs have rotted down even further some little difficulty may be experienced at first in the control of the better class forms of cover, and discriminate pruning will have to be employed if the best results are to be obtained.

No draining is necessary as if the piling has been properly carried out there should be practically no wash.

The chief draw-backs to the above system would appear to be danger of fire in the drier districts until the piled up jungle has rotted off, and also increased damage from jungle pests which can lie up and breed in the litter; bandicoots and rats will be found the chief danger and the plants may have to be protected at first against these.

Unfortunately most of the jungle which the majority of Ceylon estates had left over was land either on top of the hills, or very steep slopes which had been considered unsuitable for planting in the past and this also will have to be taken into account in deciding what method to employ in opening up. Where the land is very steep or full of boulders it may be found almost impossible to either fell on the contour or arrange for tree trunks to lie flat on the ground to form the necessary terrace to prevent wash; also in the very thick bamboo jungle in Ceylon it will probably be found that the bamboo will grow up in the uncleared areas, and choke off or badly check the growth of the better natural cover, and it will be either

impracticable or most expensive to remove the bamboo roots, and in these cases the following method, which has been tried out on this type of land, might be recommended.

The jungle was felled and lopped in the usual manner, though where possible trees were felled on the contour, all bamboo being cut down to near ground level; the felled jungle was burnt off as soon as possible to allow only a very light burn sufficient to burn off the undergrowth but not the tree trunks and larger branches, so that as little damage should be done to the top soil as possible. Practically none of the timber was burnt, and it was possible to saw up and remove all the better woods available; actually Milla trees were not felled with the rest of the jungle, and it was found very easy to cut and either saw these up, or use the smaller trees for fencing posts. Illuk and bamboo roots were forked up and removed, but after this all natural cover and weeds were allowed to grow up and only grasses, Mikania and bracken were pulled out. Shallow drains 6 inches deep and 12 inches wide at a slope of 120° were cut 20 ft. apart, and these were silt pitted with pits 6 ft. long by 2 ft. deep and 2 ft. wide and 6 ft. apart; lining was then done midway between the drains, and the lines of holes, 15 ft. apart, were also put in at a slope of 120°; this avoided most of the constant breaking of lines as is usual with contour planting, and also kept the line of holes away from the drains and silt pits, thus giving plenty of room for root growth.

Holes were cut $2\frac{1}{2}$ ft. by $2\frac{1}{2}$ ft. by $2\frac{1}{2}$ ft., though these may have been unnecessarily large; filling was done with the best soil available mostly collected from behind boulders and top soil taken when cutting drains and it was unnecessary to remove any top soil from round the holes. Directly after the burn the land was broadcast with leguminous plants seed, such as Crotalarias and Tephrosias, to obtain some form of cover to check wash until the natural covers, some of which are rather slower in growth, came away; these came away quite well over the majority of the acreage, and also a good cover of Madu Wel came away very quickly and by August 9th, 1939, when there was a rainfall of 20 inches, most of which fell in some six hours, practically no damage was done and there was very little silt to be found in the pits owing to this and the growth the natural covers had made.

All the better growths of natural cover such as Kenda, Keppitiya, Pinna, Burulla, etc., came up well and in a very few months there was a thick growth over most of the area. The Madu Wel has now started to die off owing to the cover and has not grown over or in any way checked the growth of the other cover at all. A certain amount of leguminous creepers including *Pueraria javanica* and *Centrosema* were planted out, and these appear now to be unnecessary and may have to be eradicated if they are found to start choking out the natural cover.

It is proposed to cut terraces 3 ft. wide between the stumps shortly and these will be kept clean, though if found to act as drains owing to the holes being cut at a slope of 120° will have to be blocked either by cover or a ramp of earth.

The cost for this type of opening compared very favourably with the cost of rejuvenation methods and the total cost on a 113-acre clearing including fencing, planting up with budded stumps, and the manuring programme carried out, amounted to Rs. 136 an acre. In this case it was considered unnecessary to mix manure with the soil in the hole and two applications two months and eight months after planting were given.

Generalization

Cover.—In both the above methods the chief point is that the form of cover established being natural to the country has every chance of being a permanent one, as many of the types that will appear we already know will continue to grow under heavy shade and in some cases have already done well under old rubber. It will be readily understood that the success of both these systems, mainly consisting of the use of natural cover, will largely depend on the close study of the better class plants available. We have very little knowledge on this subject in Ceylon at present, and an interchange of views between those experimenting would be of the greatest assistance at this stage.

Discussion

Chairman.—The discussion on the two papers will be taken together and in submitting questions I would ask you to mention to which paper you refer.

Mr. S. F. H. Perera.—In opening up jungle and planting it in Rubber, I suppose Mr. de Saram employs Sinhalese ; Mr. de Saram has spoken of line colonies. I would wish to ask Mr. de Saram whether these line colonies are more popular than scattered lines. I would like to know what Mr. de Saram means by line colonies.

Mr. De Saram.—A group or set of lines. In a big place it is very desirable to have the labour grouped together as much as possible.

Mr. Perera.—I am afraid the Sinhalese labour force will not like this grouping together. In the case of Tamils it may be suitable, but Sinhalese wish to have isolated huts or cottages.

Mr. de Saram.—I agree with Mr. Perera that they would like to have isolated cottages. By the use of the word "colony" I mean merely the grouping together of houses.

Mr. E. T. Fernando.—When labour is housed in lines adjacent to one another it is easy to carry out the necessary treatment for the prevention of malaria, etc. I do not think it will be difficult to persuade Sinhalese to live in lines close together.

Mr. G. B. Foote.—I should like to support what Mr. Gwynn has told us. I certainly think that the best method of conserving the soil is that of planting without burning. I saw experiments conducted in Malaya with a method of poisoning the trees, but there was great difficulty in getting coolies to go to the land owing to the falling timber. It is certainly true that the advantages of planting without burning are many. Of course there are disadvantages but, generally speaking from my own experience, I support Mr. Gwynn's views.

Mr. E. W. Whitelaw.—You may have much trouble from bandicoots, rats or porcupines if you adopt this method.

Mr. Gwynn.—I think I have mentioned that point in my paper. The chief drawbacks to the above system would appear to be danger of fire in the drier districts until the piled up jungle has rotted off, and also increased danger from jungle pests which can lie up and breed in the litter. Bandicoots and rats will be found to be the chief danger and the plants may have to be protected at first against these. It may be necessary to fence round if serious damage is done.

Mr. Foote.—In Malaya an enormous amount of damage was done by rats.

Mr. Whitelaw.—One has to go very carefully with the new system. As Mr. Bruce Foote has stated, much damage can be done by rats and bandicoots.

Mr. Gwynn.—Where you have a thick cover of Pueraria rats and bandicoots may also breed and do an enormous amount of damage.

Mr. D. L. Nicol.—The essential features of the method of opening virgin jungle without burning have been fully discussed by Mr. Gwynn. I wish to deal briefly with certain aspects of this method of opening up to the time of planting and give relative costs gained from experience in opening 10 acres jungle land at Nivitigalakele for the Rubber Research Scheme.

The land is situated on a very steep hillside and is in medium forest.

The various operations are set out in the order of sequence in which they have been undertaken:

(1) It was necessary first to explore the jungle and ascertain an idea of the nature and lie of the land. This was done by opening inspection paths through the jungle. A general study of the land provides valuable information for subsequent clearing operations and is particularly useful from a point of view of determining the position at which lining should be commenced. According to accepted practice it is considered that contour lining should be started on the steepest part of the clearing so that the lines will tend to diverge rather than converge and thus provide the maximum number of unbroken contours.

(2) *Lining and Clearing of Rentices.*—This work was carried out in two stages.

(*a*) *Lining and Preliminary Clearing of Rentices.*—These two operations were carried out in conjunction with each other, sufficient undergrowth being cleared to define the position of the contour as sighted with the road tracer. Pegs were inserted at intervals of 40-50 ft. to demarcate the line of the contour. Successive contours were spaced 24 ft. apart and intermediate contours were inserted where adjacent contours diverged to more than 40 ft.

(*b*) *Final Clearing of Rentices and Lining.*—The rentices were cleared of undergrowth to 3 ft. on each side of the initial contour lines giving a cleared rentice of 6 ft. in width. Lining for holes can then be carried out in the usual way. Costs of the different works in the various stages were grouped together under their respective headings and amounted to as follows :—

Lining, including cost of pegs, Rs. 2·87 per acre.

Clearing Rentices.—Rs. 3·60 per acre or 13½ cents per chain. It is interesting to note that 27 chains of rentices were cleared per acre out of a theoretical 28. Holing has not been fully completed but the final number of holes will amount to about 105 per acre against a theoretical stand of 121 for the planting distances adopted, namely 15 ft. by 24 ft. This is accounted for by the rocky nature of the land.

(3) *Holing.*—The next operation was holing, which there is no need to describe in detail.

(4) *Felling Along Rentices.*—This operation is an essential requirement of this method of opening. All trees along the cleared rentices which coincide with the position of the planting hole or trench are felled from below ground level after the roots have been cut sufficiently round the base. This obviates the necessity for subsequent stumping. Costs amount to about 75 cents per chain or Rs. 20 per acre.

(5) *Trenching.*—Trenches 18 ins. deep, 2½ ft. wide and 10½ ft. long (which is the intermediate space between two planting holes) are being cut after leaving a buttress of uncut earth 1 ft. thick between the hole and the trench. The surface soil removed during excavation of the trenches is thrown on the upper side and later used for filling holes. The subsoil is being built up in the form of a bund on the lower side of the trench. Trenching is given out as task work at 2¾ cents per 1 ft. On this basis the cost per trench would be 29 cts. or Rs. 30·45 per acre. The actual cost, however, inclusive of head money payments and supervision charges would amount to about 32½ cents per trench or Rs. 34 per acre or Rs. 2 per chain assuming that 16½ chains cutting is done.

(6) *Filling.*—Filling is done more or less in conjunction with the cutting of trenches. The holes are being partially filled at

first and completed later. The cost of partially filling holes to approximately 1 ft. from the top amounts to 6 cents per hole on task, or an inclusive figure of 7 cents with supervision charges and head money payments, or Rs. 7·35 per acre. Final filling costs 1¼ cents per hole or Rs. 1·31 per acre. The total cost of filling amounts to 8¼ cents per hole or Rs. 8·66 per acre.

(7) *Final Felling of Jungle Trees between Contours.*—No undergrowth is cleared except where it interferes with actual felling operations; in such cases only the minimum amount of clearing is done. The trees are cut at 4-5 ft. above ground and felled across the slope of the hill with the aid of a rope. The tree trunks and branches are cut into lengths of 12-15 ft. and stacked between every pair of contour lines with the timber lying as close to the ground as possible to prevent surface wash occurring from underneath them. A certain amount of levering of timber into position has been found necessary, particularly in cases where the tree had fallen off the line of the contour. Saplings are allowed to stand, but these are generally smothered by the weight of falling trees. The cost of this work, inclusive of cutting and stacking, amounts to about Rs. 18·50 per acre.

It has been suggested that one of the drawbacks of this method of opening is the danger of fire after felling. This can be avoided to some extent by deferring the felling until the end of the dry period or the advent of inter-monsoonal rains, when the risk of an outbreak of fire will be greatly lessened. These remarks are applicable in the case of small clearings and may not altogether be practicable in the case of large ones. The main advantage, however, in leaving felling for the last, lies in the fact that the earthworks can be carried on with less interruption owing to soil conditions becoming unworkable in prolonged periods of drought, as might otherwise be the case. Then again there is the small advantage, nevertheless an important one, that working conditions for labourers are improved when earthworks are completed with the jungle trees still standing.

Costs may appear to be high, but this is generally unavoidable when a small acreage is cleared. There has also been a general scarcity of labour in this part of the district owing to extensive clearing work being done, and consequently, considerable increases

in wages have had to be made. Costs will depend largely on the type of land being cleared, the density of the jungle and local factors.

Summary of Costs up to the Time of Planting

		Rs. cts.	Per Acre Rs. cts.
1.	*Lining*		2 87
2.	*Felling and Clearing*	Rs. cts.	
	Clearing rentices...	3·60	
	Felling along rentices...	20·00	
	Felling and stacking	18·50	42 10
3.	*Holing*		
	Holing	18·00	
	Loosening holes at base	1·75	19 75
4.	*Dynamiting*...		8 00
5.	*Trenching*		34 00
6.	*Filling holes*		8 66
7.	*Leader drains*		4 00
	Total cost up to the time of planting ...	Rs.	119 38

The only essential difference in cost of this method of opening, compared with ordinary methods, is in felling and clearing. The higher cost under this heading may partly be offset by less anti-erosion earthworks and probably lower costs of weeding.

Mr. J. D. Tarquharson.—Both papers argue against burning, but to my mind it is not so bad as it has been made out. What did they do in the olden days? The jungle was cleared by burning and the Rubber plantations grew well enough. Most of the damage was done by clean weeding and ill-advised drainage. If you follow up at once after burning the damage done is very little. Mr. Gwynn advises the logs to be left to rot on the contour. How long are they to be left to rot? And when they disappear what happens to the soil? It goes down the road.

Mr. Gwynn.—It does not go down the road. By the time the logs rot you have a good amount of cover which will hold up all the soil.

Mr. E. C. K. Minor.—What is the meaning of "shelter wood" as used on page 65 of this book?

Mr. de Saram.—I have used the word in its forestry sense. It is a sort of selective felling—cutting down of undesirable trees. It

is merely a suggestion for thought. A book describing and illustrating the main species of natural cover would be of great value.

Mr. Gwynn.—In my method and also in the case of Mr. de Saram's paper the chief point is that the form of cover established, being natural to the country, has every chance of being a permanent one. It will be understood that the success of both these systems will largely depend on the close study of the better plants available.

Mr. Atkinson.—We have discussed the clearing of the jungle and other matters relating to the jungle, but we have not discussed Rubber planting. Can you tell me at what distance the jungle covers should be kept from the Rubber trees ?

Mr. Gwynn.—That is a very hard question to answer. It was only last year that we were allowed to plant any jungle land and I have very little knowledge of the subject myself. I am afraid I cannot add anything more to the information I have already given.

Mr. Murray.—We have listened to very varying expressions of opinion on the subject of these two papers, mainly turning on the question of " no burn " *versus* the old-fashioned method of burning. It is not at all easy to gauge the general feeling of the meeting, as not many of you have had the opportunity of gaining experience of opening jungle by modern methods. It is clear that the two authors feel that an improvement on the old-fashioned methods is possible. On the other hand, there have been expressions of opinion to the contrary, and I gather from the applause which greeted Mr. Whitelaw's contention that we should proceed very carefully with any new system and that the planter remains a staunch conservative and—quite rightly—would hesitate before adopting any method that has not been thoroughly tested and proved satisfactory.

So much for the general trend of opinion. My own feeling is strongly in favour of the " no burn " method, for I feel that in the long run the advantages will far outweigh the disadvantages. The advantages, as I see them, are as follows :—

(1) The conservation of the food value and organic matter locked up in the forest trees, a great deal of which is dissipated by burning.

(2) The avoidance of partial soil sterilisation due to the heat of the burn, the importance of which is not clearly known.

(3) The ground is at no stage exposed to erosion and the harmful effects of direct sunlight. This is inevitable if the jungle is burned during the period between the clearing and the construction of drains and establishment of cover crops.

(4) Work can be started at any time of the year without reference to dry seasons.

(5) The ground does not become unworkable in dry weather so quickly owing to the shade of the standing trees.

(6) Natural covers should regenerate more rapidly. There is evidence from Malaya that provided the natural covers are sufficiently controlled they will not seriously interfere with the growth of the young Rubber plants. That is an important point to bear in mind. Mr. de Saram stated that a book with figures and illustrations of natural covers would be of value. I should like to say that a Manual on Weeds has been prepared recently by the Department of Agriculture and, subject to there being no shortage of paper owing to the war, will be issued shortly.

(7) The " walls " of piled timber and secondary growth should afford useful wind protection for the young plants.

The disadvantages have yet to be studied but would appear to be :—

(i) The clearing and disposal of the timber is more expensive though this is partly or completely offset by less expense on anti-erosion earthworks and lower weeding costs in the early months.

(ii) Danger of extensive damage by rats.

(iii) Supervision may be more difficult owing to the jungle debris between the planting lines.

(iv) The danger of fire, but this can be overcome if the felling is deferred until April.

Summing up the whole question, it is my opinion that the advantages of soil conservation will in the long run outweigh any disadvantages which will mainly be of a temporary nature and which can largely be overcome.

COSTS OF REPLANTING

H. W. ROY BERTRAND
(Govinna Estate)

THERE are many others with fuller information and more ability to deal with this complicated subject, and I must confess that it was due only to Mr. O'Brien's persuasive way that I consented to tackle it. I am afraid that any one who has come here expecting me to tell him just what it costs to replant will be disappointed. Various friends and Agencies have been most helpful in giving me figures for costs of opening and maintenance, but, for reasons which I shall attempt to give, it would take a commission of enquiry months to ferret out and explain fully the reasons for the great divergence between individual costs. Frankly I do not expect that this paper will, or can, add much to our general knowledge of the subject. The only reason for my consenting to take on the job was that it might serve the purpose of a conference by stimulating discussion and eliciting knowledge. You will realise this when I tell you that among the various costs examined there are variations between Rs. 73 and Rs. 300 for opening only, and between some Rs. 200 and Rs. 600 up to the " in bearing " stage.

Like a young S.D. with a towel round his head at his first Check Roll I have tried to unravel the causes for such variations. In many cases, not knowing the particular conditions, the reasons for exceptionally cheap or expensive working were harder to trace than the missing " half name." I shall discuss some of such anomalies later. Meanwhile one thing emerges, and that is the diverse methods of Cost Accounting of different Agencies. For example, some charge " Superintendence " which, in some cases, may mean a part of the Conductor's pay, in others, a special K.P., the acreage charge for which may be big or small. Some Agencies pay " Opening Commission," some do not. Some charge proportion of all general charges, others not.

When it comes to the details of expenditure there is no agreement as to the distribution of items. For example, take " Felling and Clearing," a big initial cost. The figures give no indication of what work was done, whether tap-roots and laterals were removed, or whether the contractor was, in some way, remunerated for the timber which he may or may not have been able to remove at a profit. In another one finds " Filling and Planting " lumped together. The total may be exceptionally high or low, but how is an outsider to know if the money was well used or not, or whether, say, the important work of " Planting " had been skimped and whether the high cost was due to having to carry filling earth, or that say 6 cts. had been added to the " Filling " cost in the form of manure.

In several cases estates which have opened a number of clearings have lumped together the costs of maintenance of two or more clearings after the second or third year. Anyone who has had to deal with accounts of a number of different companies and Agencies will realise, I think, that there is a demand for a uniform system to be adopted by all. Even in " Revenue " accounting one comes across some extraordinary survivals, so that in the newer " industry " of replanting with high yielding material it would be surprising if there were not even greater room for more accurate and informative methods. This seems to me to be of particular importance where, not only are we cutting out a relatively big source of possible revenue, but we are also dealing with a large capital outlay on a job about which there is still so much to learn.

I am aware that not only with Directors and Agents, but also with Planters I am treading on holy ground. We all like the type of accounts we are used to, nevertheless I hold that the " engine " of replanting accounts is, in many cases, in the same state of development as the old Hornsby's with their excrescences of rods and knobs, which have been made not only more efficient but more simple.

Unfortunately, also, the financial year and the planting year do not always agree. The real cost of " Opening " should, presumably be up to the date of budding a seed-at-stake clearing, or of planting budded stumps. These periods differ greatly. Moreover, weeding is one of the biggest, in many cases the biggest, cost

of " Maintenance." A December-year Company may finish its planting in that month and thus would have little to charge to weeding, whereas a March Company planting in April, and charging the previous " Opening " works to a Suspense Account, would have 11 months of weeding and upkeep in its " first year."

I happen to know an estate which in the third year of " Opening " is still struggling with so large a number of " Supplies " and deferred costs of clonal seed and budwood that it would flatter these clearings to put them in a normal " Maintenance " category.

I therefore suggest the appointment of a committee to go into the whole question of replanting accounting and endeavour to get a more uniform and informative system adopted.

Working Costs of Opening

Thanks to friends too numerous to mention, both in Agencies and on estates, I have had the chance of examining a great number of costs. The variation both in items and totals is considerable, and before going any further I should like to stress two points which examination of these figures and of my own experience in managing and visiting bear out. The first is that " Opening " costs vary intrinsically with different conditions, such as the kind of work done, the slope or nature of the land, the outlet for sales of firewood, the supply and cost of labour, the local standard of leisure, the forethought of directors, and the experience of the superintendent and staff.

The paper would run to unnecessary length if minor items such as Lining were discussed. Non-recurrent sums of a rupee or two per acre are unimportant.

Felling and Clearing

The figures run from a *credit* of Rs. 24 per acre to a maximum cost of Rs. 73 per acre. In the first case the land was not rocky or steep and was bounded by a river, so that the removal of trees and roots was easy and transport of firewood cheap. In the second case conditions were the reverse. This figure will also be influenced by Fomes. If root diseases are prevalent the removal of roots must be thorough. The average of all the figures examined was Rs. 40.

Holing

In a number of cases this was lumped with " Lining " and in some " Filling " was included. Costs vary greatly, in fact from Rs. 10 up to Rs. 35. They will, of course, vary with the number of holes per acre, their size, and with the slope and nature of the land. On steep land more cutting is necessary and in very rocky land labour has to be compensated in some way for the number of " half " or useless holes. My impression is that under average conditions the cost of 130 to 140 per acre, of holes $2\frac{1}{2}$ by $2\frac{1}{2}$ by $2\frac{1}{2}$ should be between Rs. 9 and Rs. 12. For holes 3 ft. by 3 ft. by 3 ft. costs usually should be between Rs. 11 and Rs. 15. On rocky land that cannot be forked a large hole seems advisable to give the plants a good start.

Dynamiting

One estate spent no less than Rs. 42 on dynamiting, holing and filling, of which dynamiting cost Rs. 7. More than half of the estates spent nothing on dynamite.

Filling

Costs vary between Rs. 8.50 and Rs. 17.50. This, naturally, depends on conditions, and whether, as is sometimes stated and sometimes not, manure, costing from Rs. 4.50 to Rs. 6 has been added to the holes. It also depends on the care with which the work is done.

Stirring

Breaking up the bottoms of the holes with a crowbar may cost between Rs. 3 and Rs. 4 per acre. It is a useful practice.

Planting

In several cases this was lumped with " Filling " and one cost was Rs. 26.70 per acre. But apart from these cussword puzzles the maximum was Rs. 10 and the minimum Rs. 2.47. In the case of a seed-at-stake clearing the cost was Rs. 3 for collecting, germinating and planting. As regards planting of budded stumps the result of my enquiry seems to indicate that some estates were not spending enough on this important work.

Cost of Budded Plants

This figure, of course, varies enormously, among those examined from nil up to Rs. 39 per acre. Where people have thought ahead, laid down and multiplied up ample amounts of good clones, the nursery may show a handsome credit by sales. On the other hand, for any but a very small part of a clearing, bought budwood of the more recent and expensive clones is out of the question. Nevertheless, the desirability of planting small areas in order to test such clones under the estate's particular conditions should not be lost sight of. Apart from subsequent yields, the cost to the bearing stage will be much affected by the habit and rate of growth.

Another but less big variant in the cost of plants is that of preparing, fencing, and planting a nursery. In exceptional cases the forking and preparation of the beds is no great matter. If a suitable and reasonably square block can be found fencing is relatively inexpensive. If the soil is good and water handy no great outlay on manure, watering or disease control may be required. Illustrating this the planting director of a very big Company in French Indo-China said, " Oh, we just plough up to 40 to 50 acres with buffaloes and plant the seed " ! Compare this with the man who has to hunt round to find two or three only passably suitable but irregular areas of rock, roots, and laterite which have to be hand worked over at great expense, heavily manured with an expensive organic " mix," where water may have to be carried a long distance, and where, owing to bad soil or element deficiencies, disease control is high and the percentage of good buddable plants low. From unavoidable causes the costs may vary from Rs. 200 per acre of, say, 15,000 good plants after thinning, up to or even exceeding four times that amount. *But a successful replanting begins in the Nursery.*

Weeding

Here is a particular example of the futility of attempting to generalise on costs. Those given me for the first year vary from nil up to Rs. 35. Moreover, weeding is a recurrent cost, and from examination of records I find that up to the bearing stage as much as Rs. 100 per acre may be spent. On the other hand, by luck, or good management, this may be reduced by half. This item is

often so costly, and its proper management has such a far-reaching effect on the growth of the rubber that a few observations seemed called for, though doubtless they are banalities to many.

In the majority of cases a first year's cost of Rs. 35 for weeding would be preposterous, but take the case of an estate which since the "slump" has been allowed to revert to a seething mass of grass which has seeded freely for years. If it is intended to replace this, when replanting, with legumes, heroic measures may have to be adopted from the start. It may pay, and in such circumstances, I think, does, to begin cleaning up before felling, and in land abandoned to grass this will at first prove extremely expensive. In any case, it seems wise to begin cleaning up before felling, because even a small amount of grass which cannot be tackled during the interim of felling and burning off, or of the removal of timber, may cause expensive trouble later. But that means looking ahead. If the Superintendent is asleep, as most of us are occasionally; or doesn't like to ask for the extra money to begin stamping on the weeds before the top shade is removed; or if the Directors suddenly decide that they want 100 acres replanted immediately, if not sooner; the result in such cases is likely to be a high cost of weeding, or a stunted clearing and loss of soil.

Methods of opening affect weeding costs. Where much "spoil" is thrown down the hill a comparatively large weed seed area will be swamped. A right policy of, and expenditure on, high shade and cover crops should also undoubtedly go hand in hand with weeding.

On an estate which has been clean weeded for years or has established a cover of *Pueraria* or *Centrosema* weeding costs will be low. In some cases the land has been kept so "clean" for years that it will hardly grow weeds or rubber.

But, I think, that the main thing to remember is that there should be no facile generalities. It should be our object to work to the lowest possible cost for the particular circumstances, but we shall most certainly defeat that object if we attempt to impose cast-iron rules to conditions to which they cannot be applied.

Shade Trees and Cover Crops

Amounts spent on this vary from nil to over Rs. 17 per acre. Cover crops and weeding are closely connected in their effects on

growth and costs. Generally speaking, my impression is that not enough is spent at the very beginning on establishing and manuring suitable cover. Some people's experience would appear to indicate that the planting of Albizzias should be deferred for a year or even more, until the rubber roots have got well out of the holes. The essentials for a good cover crop are that it should protect the soil; be nitrogenous ; suppress weeds ; be easily established and controlled ; should not be too voracious ; should not be particularly subject to the more serious diseases of rubber ; and, preferably, should not be a climber. Of the many ground covers that I have seen or tried the two that I like best are *Desmodium ovalifolium* and *Tephrosia senticosa*. The former must be planted out from a cuttings nursery which means thinking ahead. *Senticosa* is planted from seed.

Fencing

This is another highly variable item. Milla posts may cost anything from 20 to 50 cts. each, cement posts up to a rupee.

In some of the accounts examined there was no fencing, the average was round about Rs. 15 per acre, and the highest Rs. 38 using iron standards. Another cost Rs. 29 due to a long boundary and to having to fence a cart road on each side.

If a progressive plan of replanting has been well considered much fencing can be used again (if it is not stolen) and if live fencing can be grown it much reduces the cost.

Good fencing is usually imperative on account of the serious damage caused by stray cattle. The Malayan type of open cattle " gate " is useful and saves time.

Tools

Charges vary from nil to Rs. 12.88, and Contingencies are between nil and Rs. 10.50. In one case these two items added Rs. 20 to the cost per acre.

Platforms

Where clearings are opened on this or similar " hold-up-all-the-water " systems the cost varies between Rs. 16 and Rs. 70 according to the nature and steepness of the land. The contour-trench system appears to be rather cheaper.

Pitted Drains

Figures given vary between Rs. 14 and Rs. 36. It would appear that a well-traced and a fully pitted drainage system costs about Rs. 28. The cost is less affected by the slope of the land than by its rocky or stoneless nature. In many cases old drains are used or partially modified and 5 ft. or 6 ft. pits cut, 18 ins. to 2 ft. deeper with a block of 3 ft. between each. Such work usually costs about Rs. 8 to Rs. 10 per acre.

Roads

As often as not these are lumped together with drains, and occasionally with platforms, so that one would have to be a "Times of Ceylon" Tamil Seer to get anything out of comparative statements. But, for what they are worth, the figures given me vary from Rs. 1.30 up to Rs. 36 ! Occasionally an item "Cart Roads" appears and various amounts up to Rs. 5 have been charged. It is not a work for which one can lay down any generality. Of one thing I am convinced, and that is of the great value of motorable accessibility to and through clearings. No one who is well acquainted with the dozens of little things which require immediate attention if the plant is to succeed, will deny that one may visit a replanted area six days a week and on every one of them see some small matter to be put right.

Anybody can plant up a 60 per cent. success clearing and go on "supplying" it for the next three years, and then end up with an expensive and uneven planting, but it takes an enormous amount of keen and personal attention to get even a really good 90 per cent. success where every plant has got off the mark and kept going. But, however keen and capable a Superintendent may be they cannot get that attention from one who has many other calls on his time, if he has to walk and climb two or three miles to get there. Moreover, a motorable road is not a recurrent cost. Its upkeep is negligible, and, going beyond the opening and maintenance stage, I expect many of you have had a cold feeling when looking forward to the amount of supervision that the tapping of budgrafts will require.

Manuring

Figures given vary from Rs. 13 to nil. As presumably nobody would spend Rs. 13 on manuring holes, it is probable that this

amount was partly spent on the holes and partly on a subsequent dose. Where figures for applications to the holes are available these normally cost between Rs. 5 and Rs. 6. The dose 3 to 4 months after planting usually costs about the same.

Seed-at-Stake Clearings

I should have liked to give comparative figures against budded stumps clearings, but the conditions of planting and individual costs vary so much that it would take a far more detailed enquiry to get much out of it. On the face of it one would presume that a seed-at-stake clearing would cost more, as it requires at least a year's longer maintenance before budding. Moreover, in my own experience of "visiting," such clearings are more of a muddle and less even than a good budded stump clearing, *provided that everybody has thought ahead*, that the "planting" has begun with a nursery originally at least double the size wanted, subsequently well thinned; and that the Superintendent and staff know their job thoroughly. It is interesting to note that Mr. Kennaway, in one of his recent articles, states that in the Straits, now that the technique of planting budded stumps from a nursery is becoming better understood, this method is gaining in popularity over seed-at-stake.

Planting clonal or special seed garden seed may cost up to Rs. 60 per acre for the seed and supplies alone. Some of the finest seedling growth I have ever seen has been from such, both here and in India, and some of the worst. Often there is difficulty in getting it in the right planting season, which, when it arrives, may entail worry and expense on care and watering. Also, no such seed is so pure that one should not allow a wide margin for subsequent removal of "duds." There seems to be a general consensus of opinion that one should plant about 200 "points" of clonal seed per acre, as against some 130-140 of budded stumps. This means about 50 per cent. extra expenditure on holing and filling, and a good deal more later on test tapping and thinning out. A further point, which so far may have been overlooked, is the suitability of the particular seed to its future environment. Most of us now realize that certain clones are best suited to certain districts. It seems possible that the purer the line of seed the more will this generally tend to restrict its universal use, but this is no condemnation of clonal seed. Hand in hand with budding it offers the

chance of some magic cross which may lead to greater efficiency and freedom from disease.

Total Costs of Opening

From the foregoing it will be appreciated that total costs vary greatly. One of the lowest given me was Rs. 122 per acre, but, apart from holing, filling and felling practically no field work except some weeding and planting of covers had been done. The highest "First Year" cost was Rs. 294. In this case, on account of inaccessibility and of much Fomes, removal of trees and roots was very expensive. Moreover, planting was finished early in the year and some Rs. 64 were subsequently spent, in the same year, on maintenance, a good deal of which was on Fomes.

The lowest figure given was Rs. 91. In this case the timber was given to the contractor to cover cost of uprooting and existing drains were pitted. Maintenance in the following year cost Rs. 102, but this was a seed-at-stake clearing, so it seems obvious that a good deal was spent in the second year that would normally go to the first year with a budded stump clearing. The average first year's cost of all figures examined was Rs. 174. It should be remembered that some of the lower opening costs given were incurred some years ago when labour was cheaper and more abundant. With so much replanting and new clearing work going on there has been a considerable rise in the cost of labour in some districts, and even shortage.

Maintenance

The average costs for the 2nd, 3rd, 4th and 5th years worked out at Rs. 51 ; 50 ; 43 ; 36 ; 37 ; I was unable to get enough representative figures for the 6th and 7th years, but it is interesting to note that two estates spent so much more on manure that they averaged Rs. 45 and Rs. 50 respectively for those two years. Only a much more detailed examination of accounts than I have had the time for or the material to work on, could show what difference in maintenance there is between seed-at-stake and stump budded clearings. I can only state that from the figures given there is not a striking difference, but there are so many varying factors. One important point is noticeable. "Supplying" seldom comes into the accounts of nursery budded clearings after the second year from planting, whereas in the case of clearings budded in the field one finds charges

for supplying in the third year and occasionally even in the fourth year. This extra cost may be in itself, no great matter, but it indicates serious unevenness of growth and the whole object of any system of planting should be to get 100 per cent. plants off the mark and into production in the shortest possible time. In my own " visiting " experience I have met men who are keen advocates of budding in the field and there is, of course, no alternative when Directors suddenly decide to replant large areas without forethought for nurseries and budwood. And in making this remark I don't want anyone to think that I am merely chucking bricks at directors. The profits and costs, and the horizons of this new industry are so changing, and the technicalities of clone; environment; of methods and of labour are still so little understood, that I feel that even those who have given the most thought and have had the best opportunities of studying the subject are still fumbling in the dark. It would be grand if I could tell you with complete assurance what and how to replant and what it should cost in any particular circumstances but only a very " smart Aleck " could do that.

A word should be said regarding planting with big bud saplings, or " stumped buds." Given suitable weather, this would be the quickest way of bringing a replanting to the bearing stage and would probably give at least a year longer for tapping the old rubber. In India, where one can depend on several weeks of wet weather after the monsoon bursts we have had some excellent results, but my experience in Ceylon has been less fortunate. If the June rains fail, as they have done occasionally, there is bound to be serious die-back, though plants seldom die out completely. On the whole, I consider the method unsuited to the vagaries of the Ceylon climate, but big stumped buds can be a valuable stand-by for late supplying.

Regarding total costs I can hardly do better than quote the remarks of two friends in Agencies. " It is extremely difficult to arrive at any comparative costs between estates . . . Figures for clearing, replanting and the maintenance of areas show large variations, and the only thing that seems to be emerging so far is that estimates as originally framed are in most cases going to be fairly wide of the mark."

The other wrote that he could give me " figures " and estimates, for what they are worth, for replanting up to the bearing stage, of anything from Rs. 200 to Rs. 600.

My own impression is that, making due allowance for normal local variations, due to the points raised, the cost to the bearing stage on the majority of estates will vary between Rs. 450 and Rs. 550 per acre. I am aware that in many cases it can be done cheaper, and, though it is far from my intention to advocate unnecessarily expensive working, I do often come across the case where a good ship has been spoilt by saving the extra ha'porth of tar.

There is a point which I believe both Agents and those who have the responsibility of " Visiting " will appreciate. Where costs are high, what is vulgarly known as a " stinker " may be deserved; on the other hand, it might not only be doing an injustice but might discourage a man who knows the local conditions from doing the job properly in future. In fact, the too general application of " generalities " when dealing with plants and humans under such a diversity of conditions is not likely to give the best results, and, though Agents and Directors are busy people, the more time they can spare to visit estates, see and discuss the work, the better will be the results for all.

A further point. Ceylon is but a small pebble on the beach of production. In research, applicable to our own conditions, we are necessarily handicapped by limited resources. Nevertheless, much useful work could be done by Agencies and Planters in collecting and correlating information. Take, as one example, the rate of growth. A shareholder or proprietor would like to know how effectively his money is being turned into tappable trees. I think all estates should try to adopt some uniform method and time of growth or girth sampling.

This also would give valuable information as to the need for manuring. If growth is much ahead a saving can be effected, if it is much behind there is probably an indication that by spending more on manure the expensive period of maintenance may be reduced.

This is an unsatisfactory subject to be asked to speak on, and I can only hope that this paper will lead to an interesting and useful discussion.

Mr. G. B. Foote.—With reference to what Mr. Bertrand has said in connection with working costs, they were quite the standard before the cry went out that replanting costs were too high. The cry came from the Far East. Having seen some of these clearings last year one realised that the Far East can open up land cheaper than we do. They have better land, labour is cheaper and they never fence in the Dutch Indies. If you spoke to a Dutchman regarding fencing he would look upon you as a harmless lunatic. I have seen thousands of acres in Sumatra and never saw one yard of fencing. There is no damage by cattle because in the Dutch East Indies they make the village look after their cattle and cattle were not allowed to stray all over the country. I trust they will do this in Ceylon too. It may interest you to hear something about costs. The highest cost given me by an estate in Malaya was between Rs. 420 and Rs. 450 an acre which, I think, is fairly expensive considering that the earth work is cheaper and there is no fencing. Manuring was much less required there because soil conditions are better. In Sumatra I was given the low figures of Rs. 170 to Rs. 190 per acre. Their methods were different and in one plantation Fomes broke out among 50% of the trees within the first two years. On the whole the costs there are much cheaper, but I do not know whether the results, as a rule, justify that.

Mr. Bertrand.—If I may refer at this stage to a point raised by Mr. E. W. Whitelaw in his interesting paper, I think the failure of many of the earlier clearings was due to attempts to work on the "cheap" in circumstances which did not permit cheap working.

Mr. M. Atkinson.—On the subject of weeding costs my experience is that the policy of clean weeding before felling is unnecessarily expensive for this reason; assuming that we have a 100-acre clearing to be completed in 12 months we start in January and weed the full area at a cost of perhaps Rs. 8 per acre.

From then on we are committed to weed 100 acres every month. By the time we have felled, cleared and burnt, especially if rains have been experienced, weed growth may be just as bad as it was in January, and with the monsoon ahead of us and having to weed the full area every month the work may get behind—a fatal thing—or the monthly weeding estimate may be greatly exceeded.

Given the same weeding estimate the system I have found best is to fell, clear and burn as one complete operation.

We then start at the top of the clearing with four labour gangs, one immediately behind the other and proceed as follows :—

(*a*) Cut holes. (*b*) Clean weed. (*c*) Fill holes with as much top soil as possible. It is this soil which contains all the weed seed. (*d*) Cut contour trenches, and this operation alone covers a large section of surface soil. Leaving behind a completed work we progress at the rate of about 10 acres a month and it is only during the last month that we weed the full 100 acres.

On this system there is never any fear that weeds are going to get the better of one. It is the most carefree system I know of and good work during the first year is certainly followed by greatly reduced weeding costs afterwards.

Mr. Bertrand.—I quite agree that in certain circumstances this would be the most satisfactory procedure, but take the case of the wet zone where one has to do felling as soon as one can. In some cases people sell the timber and the contractor does not take it away quickly and weeds grow.

Mr. E. T. A. Fernando.—I would like to ask Mr. Bertrand whether he has come across that individual who goes about giving ridiculously low costs, which make you feel after you have heard this wonderful fellow that you are a dud. I have asked several of my colleagues for information on this point and in every case I am sorry to say, I have been misled. I am very glad Mr. Bertrand has been able to give us this interesting information on the question of costs. Coming as it does from a planter well-known in the Rubber world I am sure it will be of the greatest interest.

THE MAINTENANCE OF SOIL FERTILITY IN YOUNG RUBBER CLEARINGS

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THIS paper deals with the nutrient requirements of young Rubber and views the question from two angles, firstly, that of conserving the natural fertility of the soil, and secondly, raising that fertility level in the case of certain plant-foods by the addition of manures.

Conservation of Natural Soil Fertility

Replanted clearings and sometimes virgin soils may be found to be deficient in one or more of the nutrients, nitrogen, phosphate and potash. Such deficiencies may be made good by the application of artificial manures, but every attempt should be made to conserve plant-foods already present in the soil. These may be lost in three ways, by leaching, by erosion and by removal or burning of the vegetation.

Serious loss by leaching occurs under conditions of heavy rainfall, and although a vegetative cover lessens this tendency considerable amounts of nutrients are unavoidably carried down below the level of root action.

Erosion is responsible for the removal of vast quantities of clay, silt and humus and as the greater part of available plant nutrients is contained in this fine material efforts should be made to conserve it by means of a suitable cover crop and efficient drainage system.

A good cover will not only hold most of the existing soil in place, but will maintain and even increase the organic matter content of the soil. This very necessary constituent of a good soil cannot be hoarded. It is continuously undergoing a process of decomposi-

tion and the losses must be made good. During certain stages of its breakdown the organic matter favourably influences soil structure and water relationships and it also acts as a bank for the holding of nutrients in an available form. To attempt to make good this loss of humus by the application of artificial organic manures would be out of the question as the amounts normally used for manuring purposes would not appreciably affect the organic matter content of the soil.

Another valuable supply of plant-food is to be found in the trees growing on the land marked for clearing and from the point of view of soil fertility the disposal of material containing considerable quantities of nitrogen, phosphate, potash and other minerals necessary for plant life is a matter of some importance.

Recent work by the Rubber Research Institute of Malaya has thrown some light on one aspect of this question. As a result of chemical analysis it was calculated that a rubber tree, 10-12 years old, 60 ft. high and of a total weight of 11,700 lbs. would contain 34 lbs. nitrogen, 11 lbs. phosphoric acid and 39 lbs. potash as well as other minerals. A stand of 100 such trees to the acre would contain plant-foods equivalent to those in the mixture—

7·4 tons sulphate of ammonia

1·7 tons rock phosphate

3·5 tons muriate of potash

At present prices and substituting nitrate of soda for sulphate of ammonia this would approximate to Rs. 2,350 per acre.

The removal of such large quantities of plant-food from off the land needs careful consideration particularly if transport conditions seriously lower the selling price of the timber and increase the cost of artificial manures.

If, as is frequently the case, the timber is burnt on the land the probability is that the greater part of the plant-food other than nitrogen is returned to the soil and will, if evenly distributed, materially assist the growth of young Rubber at least for the first few years. With respect to the more fugitive nitrogen there is certain to be a very heavy loss as most of it will be dissipated in the gaseous form.

Whilst it is not known what percentage of the total nitrogen would be returned to the soil by the process of natural decay it may be assumed that the amount would be considerable and that the nutrients in general would become available relatively slowly, a condition that may be of some importance in the supplying of large amounts of plant-food to the soil prior to planting.

If the big timber is worked into position along the contour and the smaller plant debris is used to fill up any gaps between trunk and soil the conserving of the nitrogen in the debris will be increased and the system will act as a check to the movement of the valuable fine soil.

Although a good theoretical case can be made out for allowing the timber to decay on the land there is as yet no experimental evidence that such a procedure leads to a better growth than that which follows a burn.

Manuring

Application of Manures in the Nursery.—The problem of manuring may be considered as arising first in the nursery. As the area in use at this stage is relatively small, the assumption may be made that a reasonably good soil has been selected. A gravelly soil may be improved by the incorporation of cow manure or compost. Drainage is of importance as the existence of a high water table and a poorly aerated soil will have a harmful effect on the young plant. Soil reaction may be of importance at this early stage and an initial application of sulphur is advisable if an old line site has been chosen or if the nursery is in a limestone area.

No clean-cut rules can be laid down as to the manuring programme that should be followed. The best indication is probably the plant itself and the aim should be to bring the plant to a buddable girth within 12 months.

An application of " Animal Meal " or similar manure may be made before the seeds are planted. This is a safe fertiliser and will not injure the young seedling. When the plants are about six months old an application of inorganic fertilisers may be given, but to ensure safety and as even a distribution as possible this should be mixed with good soil and dibbled in.

An experiment carried out at Nivitigalakele on the manuring of nursery seedlings has given results of some interest. Seedlings were planted in August, 1938, in a soil that had previously proved to be relatively fertile.

The manurial treatments were control (no manure), single nitrogen (·30 oz. ammonium sulphate), double nitrogen (·60 oz. ammonium sulphate), potash (·12 oz. muriate of potash), phosphate (·33 oz. superphosphate) and all their combinations. There were altogether 12 different manurial treatments and three replications, but the effective replication of each main treatment (N, P and K) was increased by the design of the experiment. The first application of manures was made in December, 1938, when the average height of the plants was 24·2 ins., a second application was given in April, 1939, and a third in July.

An examination of the measurements taken in May and in October shows a slight but significant increase in height and girth due to nitrogenous manuring and a small but significant depressing effect due to phosphate. As the above results are significant only at the lower conventional standard of probability (5 per cent.) and the actual differences between manurial treatments are small the manures may be regarded as having had little or no effect on growth. A summary of the results is given in Table I.

TABLE I

Height in Inches (May) Mean of all Plants			Diameter in Inches at 1 in. from Ground (October) Mean of all Plants						
Without N	With single N	With double N	Without N	With single N	With double N	Without P	With P	Without K	With K
61·4	62·2	63·4	1·01	1·06	1·07	1·07	1·03	1·04	1·06
Standard error per plot 1·88			·04						
Significant difference (P. = ·05) = 1·6			(P. ·05) N = ·04; P & K = ·03						

The girth measurements were also examined on the basis of suitability of the plants for budding, taking as criterion a diameter

of 1 1/8 in. and over and the smallness of the response to manures was again apparent.

At the end of October all plants of 1 1/8 in. diameter and over were budded. As the work of budding was not randomised the count of successfully budded plants could not be statistically examined but the following results are of interest :—

TABLE II

	Without N*	With single N*	With double N*	Without P**	With P**	Without K**	With K**
Number of successful buddings	89	213	210	284	228	249	263
Successes as percentage of total plants in treatment	15	36	35	32	25	28	29
Successes as percentage of plants budded in each treatment	41	79	78	69	66	69	67
Total number of plants in each treatment							*600 **900

Although manures have had very little effect on the growth of the seedlings a small dressing of nitrogen has apparently more than doubled the number of budding successes. It is known that the success of the budding operation is largely dependent on the presence of adequate food reserves in the neighbourhood of the budded area, and it seems possible that nitrogenous manuring may play an important part in building up such reserves.

It would appear that on this soil nitrogen alone is required and that the addition of minerals has had no effect, but as some evidence has been obtained that the soil is higher than the average in available phosphate and potash it is recommended that for nurseries in general all three nutrients be added, but that nitrogen be present in greater amount than the other two.

It was thought that the building up of the food supplies of the plant whilst in the nursery might be reflected in a more satisfactory growth after transplanting. Eighteen successfully budded stumps (diameter 1 1/8 in.—1 3/8 in.) from each of the manurial plots O, N_2, P, K, NK and NPK of the nursery experiment described above were planted out. Counts of the number of shoots

that had emerged were made every few days. A summary showing the average number of days from time of planting to emergence of the shoot is given below for each manurial treatment.

TABLE III

Treatment	O	P	K	N_2	N_1K	N_1PK
Days	35	43	36	29	31	33

(Significant difference P. ·05 = 3·9 P. ·01 = 5·5)

An application of nitrogen has shortened the period whilst phosphorous has increased it. This effect of manures may have little practical bearing under the conditions of this replanting but under field conditions it may be of importance if dry weather is experienced shortly after planting.

Application of Manures in the Planting Hole.—As the object is to bring into tapping a healthy tree as soon as possible after budding, attention should be paid from the start to the supply of plant-foods in the most suitable form.

Addition of manures to the soil in the planting hole is likely to prove a wise policy, but the manure should not be in such a readily available form that serious loss by leaching is likely to result. For this reason addition of artificial nitrogenous manures to the soil in the planting hole is not recommended; such applications should be deferred until about three months after budding.

On theoretical grounds phosphate and potash may with advantage be added to the planting holes in replanted areas, and this applies also, though with less force, to jungle clearings. An application at this time is of particular importance in the case of phosphate, a nutrient which tends to remain in the top few inches of soil when applied as a surface dressing. By mixing the phosphate and potash with the earth in the hole the roots will be better able to make use of these foods and a well distributed supply should be available for some time.

The raising of the humus content of the soil in the planting hole is often desirable and in particular in gravelly replanted clearings. To fill the hole entirely with cow manure or green material is neither economical nor necessary, but a few baskets of compost

or cow manure or alternate layers of soil and green material sprinkled with cyanamide to aid decomposition will not only increase the supply of plant-foods, but will serve as a habitat for useful soil bacteria, will improve the structure of the soil and will to some extent increase its water-holding power.

Application of Manures after Planting.—Until more is known of the manurial requirements of Hevea on different soil types it is suggested that a programme of manuring embodying moderate applications be adhered to. Two guiding principles may be mentioned, firstly, that of " little and often" as regards size and frequency of the dose, and secondly, that as regards the nature of the dose all three main plant-foods N, P and K be included, at least until maturity has been reached.

The general level of manuring and the NPK ratio will vary with soil type and possibly with the clone. The best form in which the nutrient should be applied may also vary with soil type and with climate. Reliable information along these lines can be obtained only by field trials and as the time required to secure results depends on the growth of the tree the acquiring of such information is necessarily slow.

In all questions of manuring the part played by possible limiting factors should be kept in view. Stunted plants sometimes fail to respond to substantial applications of a " complete " manure. This may be due to insufficient rainfall, to swampy conditions, to a layer of impervious clay or rock near the surface or to excessive competition with cover crops. At times poor response may be had to a dressing of one plant nutrient or to a mixture of two. The limiting factor may be a serious shortage of the other nutrient and if this is supplied the full effect of all may become apparent.

It is always advisable before starting a manuring programme to pay some attention to other factors that are likely to be of importance.

A manuring programme for young budded Rubber up to the sixth year after planting has been drawn up by the Rubber Research Scheme and this is revised as evidence from field experiments becomes available. Its general feature is the inclusion of all three main plant-foods, nitrogen, phosphate and potash. The most suitable ratio of the three nutrients is at present largely a matter of speculation,

but the assumption is made that the nitrogen and phosphate requirements are about equal up to the fifth year and the potash half the other two. In the sixth year the phosphoric acid level is decreased to about half that of the nitrogen and the potash drops still lower.

Field Manuring Experiments on Young Budded Rubber.—An account of manuring experiments on young budded Rubber on Dartonfield will now be given.

The first deals with an area replanted in May-June, 1938, with budded stumps and manured twice in 1939. The treatments given were : Control, N, P, K, NP, NK, PK, NPK and compost equivalent in N, P and K values to the "complete" inorganic NPK manure. The doses of nitrogen and phosphate were according to the "Programme of Manuring" recommended by the Rubber Research Scheme and the potash was increased to the same level as the other two.

The height increment figures given in Table IV. for the period March-September, 1939, show significant responses for the treatments PK, NPK and compost. The girth measurements show no significant responses to manuring, but there are indications of an increase due to NPK and compost.

TABLE IV

Treatment	Mean Height Increment in Inches per Plant		Mean Girth in Inches per Plant at 3 ft. from Ground	
	March-September			
	Actual	Increase over O	Actual	Increase over O
O	65·2	—	2·81	—
N	61·2	— 4·0	2·93	·12
P	70·1	4·9	2·96	·15
K	66·1	0·9	2·87	·06
NP	64·3	— 0·9	2·71	— ·10
NK	68·5	3·3	3·10	·29
PK	79·1	13·9	3·05	·24
NPK	78·2	13·0	3·25	·44
Compost	79·6	14·4	3·29	·48
Standard Error	4·1			
Significant difference		11·8	Not significant	

The inference from a study of the height increments is that only a PK mixture is required on this soil, but the indications that on girth measurement both NPK and compost have done better

than a PK mixture (though not significantly so) is some justification for regarding a " complete " manure as the best.

The second experiment to be described involves only three manurial treatments and was laid down on a replanted clearing planted with budded stumps in May, 1939. No manure was added to the planting holes. The first application of manure was made in September and a second in November.

(1) *Artificial Organic.*—2·9 oz. Black Label Animal Meal.

(2) *Inorganics.*—1·3 oz. Nitrate of Soda, 0·7 oz. Concentrated Superphosphate and 0·3 oz. Muriate of Potash.

(3) *Inorganics + Minor Elements.*—Inorganics as above together with additional amounts of certain minor elements over and above those present in nitrate of soda. Deficiencies of certain secondary elements are known to be responsible for abnormal development of certain plants and it is possible that this may be of some importance in the growth of Hevea on Ceylon soils.

A summary of height measurements is given in Table V below. The actual heights were adjusted by means of a regression on the preliminary September measurements.

TABLE V

Treatment	December, 1939 Ins.	January, 1940 Ins.
O	28·8	32·6
Inorganics	31·9	39·7
Inorganics + Minor Elements	31·1	37·9
Organics	35·6	40·8
Standard Error	1·13	2·04
Significant difference	3·4	5·7

The December measurements show a significant increase of the plants given an organic manure over those given the other treatments. This may be due to the leaching out of the soluble inorganic nitrogen (in nitrate of soda) before the plant could assimilate it. The January measurements show that all treatments are significantly greater than the control, but the difference between the two forms of nitrogen has narrowed considerably. The additional minor elements added over and above those present in Chilean nitrate of soda have had no significant effect.

In order to secure information on the variation in response to manures with variation in soil type, a simple NPK experiment was designed in 1938 and laid down on a number of estates.

Height and girth measurements were taken in 1939 (one year after the first application of the experimental manures) and are summarised in Table VI.

TABLE VI

Girth in Inches. Mean Value per Plant								
Estate No.	1*	2	3*	4*	5	6	7*
Treatment O	4·0	3·4	5·7	7·9	3·4	5·1	6·8
N	4·1	3·6	5·8	8·1	3·4	4·8	6·9
P	4·1	3·8	6·1	8·0	3·7	5·0	6·6
K	3·6	3·8	5·9	7·9	3·8	4·3	6·9
NP	4·0	3·7	5·9	8·2	3·5	5·0	6·8
NK	4·0	3·8	5·9	8·2	3·5	4·9	6·9
PK	3·7	3·6	5·9	8·1	3·2	4·7	6·8
NPK	4·2	3·8	6·0	8·3	3·4	4·5	7·1

* The actual measurements have been adjusted by means of a regression on the preliminary measurements. In the other three series preliminary measurements were not available.

None of the above results are statistically significant, but there are indications of small responses to manuring. It will be seen that when the actual girth measurements have been adjusted the NPK treatment occupies first place in three cases and second place in the fourth. Whilst the responses are at this stage small and non-significant they may become greater as the plants get older and the above results should not be taken as justification for regarding the manuring of young budded stumps on Ceylon soils as unnecessary.

Small but significant responses, as shown by height measurements, have been obtained on two estates, on one an increase of 9 per cent. over the control due to a PK mixture and on the other an increase of 7 per cent. due to NK.

In view of the apparent variations in the responses to different combinations of nitrogen, phosphate and potash and the fact that at only one centre out of eight is there any indication of a depressing effect due to a "complete" mixture it is considered that the evidence supports the contention that an NPK mixture is the most suitable for young Rubber.

The contention is further strengthened by the results of an experiment initiated by a commercial firm and laid down along rather different lines from the above. Only three manurial treatments were given and a control was not included. A summary of the measurements is given in Table VII.

TABLE VII

Treatment	Height 14 months after Budding		Girth 17 Months after Budding	
	Actual	Increase over N	Actual	Increase over N
N	92·7 ins.	—	3·11 ins.	—
NP	113·7 „	21·0 ins. (23%)	3·61 „	·50 ins. (16%)
NPK	117·9 „	25·2 „ (27%)	3·96 „	·85 „ (28%)
	Not significant		Standard error	·17
			Significant Difference (P·05)	·53

The measurements show that a substantial and significant increase in girth has resulted when phosphate and potash were added in addition to nitrogen.

There are two factors that may account for the much greater response at this centre than at those mentioned previously. Firstly, the quantities of N, P and K nutrients added were about three times those suggested for plants of the same age in the standard experiment. Secondly, the Dartonfield and standard estate experiments were only in their first year when the measurements were taken whilst the trial just mentioned was at the end of its second year of experimental manuring.

Organic versus Inorganic Manures.—In order to investigate the claims sometimes made for organic manures two experiments were laid down, one at Dartonfield, the other at Nivitigalakele.

The Dartonfield experiment which involves budded stumps, stumped buddings and field buddings planted in 1936 on old rubber land is a comparison between :—

(1) *Inorganics.*—Sulphate of Ammonia, Safaga Phosphate and Muriate of Potash.

(2) *Organics.*—Blood Meal, Bone Meal, Ground Nut Cake and Muriate of Potash.

The quantities of N, P and K used were those given in the " Programme of Manuring."

For the first two years after the start of the experiment differences in height and girth between the two treatments were small and inconclusive. The latest girth measurements taken in June, 1939, show exactly the same value (8·64 ins.) for both treatments.

On a pre-war price basis the organic manure mixture in this experiment cost an additional 70 per cent. over the cost of the inorganics, but the results to date show no indication of a better response to organic manures than to the cheaper inorganics if the normal estate practice of incorporating green material is followed.

A somewhat similar experiment was started at Nivitigalakele in 1937 on budded stumps planted in 1935. This involves a comparison between compost purchased from the Kalutara U.D.C. and an inorganic mixture equivalent to the compost in NPK values. The N and P applications are those given in the Programme of Manuring and the K has been raised to the same level.

Girth measurements taken in September, 1939, show practically no difference between the two treatments :—

Compost, mean girth	9·94 ins.
Inorganics, mean girth	10·03 „

Here, as in the Dartonfield experiment previously mentioned, green material growing on the experimental area was incorporated with both the organic and inorganic mixtures.

Cover Crops.—In conclusion a few remarks may be made on the advantages and disadvantages of cover crops. A suitable form of surface vegetation is necessary for the conservation of the fine soil. A close canopy over the soil will slow up the disintegrating action of rain on the fine particles whilst the roots will bind the soil and together with the aerial parts will act as a barrier to any soil wash that may occur. The fallen leaves are continuously replenishing the supply of organic matter in the soil which as stated previously is not in a static condition, but is all the time undergoing a process of decomposition and serving a number of useful purposes whilst doing so. The nitrogen content of the soil is also increased by the growing of a leguminous cover and while this may vary according to species and local conditions its effect is generally regarded as by no means negligible.

To offset these advantages there is the disadvantage of competition between cover and Hevea for applied manures and water. There is very good evidence of the adverse effect of uncontrolled

creeping cover on the growth of young Rubber, and some system of checking this appears to be necessary.

A suitable method is to maintain a clear area of gradually increasing size up to, say, six feet diameter around the young plant. As a further safeguard an occasional slicing with a spade may be made around the plant in order to cut any cover crop roots that have found their way into the planting hole. The size of this circle should, of course, increase with the spread of the Hevea roots and the treatment should be stopped when the roots appear to have reached the edge of the cleared area.

In order to protect the soil on the cover free area and to maintain the supply of humus, a covering of green loppings may be put down occasionally. By shading the soil from the sun's rays and protecting it from hot drying winds evaporation of soil moisture would be checked and a greater supply of water be available to the plant at a critical time.

Summary

The manurial requirements of young Rubber clearings are discussed and the results of field trials quoted.

Nitrogen has been found to have a good effect on nursery seedlings, but for nursery soils in general a nitrogen-phosphate-potash mixture is advised.

It is recommended that phosphate, potash and organic matter be mixed with the earth in the planting hole.

Field trials on young budded Rubber at different centres have shown only small and inconsistent responses to manures when measured twelve months after the first application. Some evidence has been obtained that in general an NPK mixture is the most satisfactory.

A three-year trial has shown no differences between the responses of young budded rubber to organic and inorganic artificial manures when the incorporation of green manure is included in both treatments.

The importance of safeguarding the natural soil fertility is pointed out and suggestions are made for doing so.

Reference is made to the need for control of the cover crop.

The writer takes this opportunity of expressing his thanks to those Agents who arranged for the carrying out of estate manurial trials and to the Superintendents of estates for their interest and hospitality.

Mr. R. C. L. Notley.—On page 98, you say that a few baskets of compost or cow manure or alternate layers of soil and green manure sprinkled with cyanamide to aid decomposition will not only increase the supply of plant food, but will improve the structure of the soil. Have any experiments been done to prove this ?

Dr. Whelan.—Not by the Rubber Research Scheme, but in general the addition of organic material to a soil may be expected to bring about an improvement in soil structure.

In reply to a question as to whether nitrate of soda could be used instead of calcium cyanamide for breaking down green material in the planting hole, Dr. Whelan said it would do just as well, but there might be a greater danger of loss by leaching.

Mr. E. T. Fernando.—My impression is that at the last conference it was agreed that the use of cyanamide in the planting hole was harmful.

Mr. G. B. Foote.—On page 103, you refer to the nitrogen content of the soil and state that it is increased by the growing of a leguminous cover which may vary according to species and local conditions. May I ask whether there is any proof of that in old Rubber or young Rubber of any description ? I was told by a Superintendent when I was in Malaya that leguminous covers did not fix nitrogen. It certainly surprised me. I further discussed the subject with the authorities of the Rubber Research Institute who told me that although there was proof that leguminous covers did fix nitrogen in certain circumstances there was no proof that they do so under Rubber.

Dr. Whelan.—They are certainly likely to increase the nitrogen content of the soil. We have not carried out experiments on those lines or taken soil samples, but experiments conducted in the United States and Great Britain have shown considerable increases in nitrogen content of the soil.

Mr. Foote.—Am I to understand that the Rubber Research Scheme of Ceylon does not hold the views held by the Rubber Research Institute of Malaya ?

Dr. Whelan.—Without more knowledge of the subject I would not subscribe to the view that legumes do not increase soil nitrogen content under Rubber.

Mr. Murray.—I do not think it is the view of the Rubber Research Institute of Malaya that in *no* circumstances do leguminous covers fix nitrogen in Rubber fields.

Mr. W. R. Thomson.—The position, as I understand it, is that the fixation of nitrogen is dependant on local conditions and the presence of the correct strain of bacterium.

Mr. H. W. R. Bertrand.—On page 93, Dr. Whelan mentions that on results of chemical analysis it was calculated that a Rubber tree, 10 to 12 years old, 60 feet high and of a total weight of 11,700 lbs. would contain 34 lbs. nitrogen, 11 lbs. phosphoric acid, and 39 lbs. potash as well as other minerals. That is a very interesting statement. In 1930-31 I replanted a small area of nine acres of Rubber. The trees were more than 60 feet high—actually they were 90 feet high. The trees were felled and the timber stacked down the rows, and a ground cover allowed to grow over the rotting stems. The results have been good, but not what I would expect from the addition of such a large quantity of plant foods.

Dr. Whelan.—As I have mentioned in my paper, whilst it is not known what percentage of the total nitrogen would be returned to the soil by the process of natural decay it may be assumed that the amount lost would be considerable. The minerals would become available relatively slowly—a condition that may be of some importance in the supplying of large amounts of plant food to the soil prior to planting.

Mr. C. Gilliat.—On pages 95 and 96 of your paper you give a description of experiments conducted at Nivitigalakele on the manuring of nursery seedlings. Can you tell me what percentage of the plants were buddable in October?

Dr. Whelan.—Sixty per cent.

Mr. Gilliat.—You state that seedlings were planted in May. May I ask whether they were basket plants?

Dr. Whelan.—No.

Mr. Gilliat.—Was there seed available at that time ?

Mr. Murray.—I am afraid there is a printer's error. The seedlings were not planted in May, but in July/August.

Mr. Gilliat.—At what distance were they planted ?

Dr. Whelan.—12 ins. by 12 ins.

Mr. P. A. Keiller.—I note that phosphate has retarded the shooting of the buds (Table III). Has any effect on growth been noticed ?

Dr. Whelan.—Height measurements of the young plants were taken a few weeks after emergence of the shoot and no differences were found.

Mr. E. J. Russell.—Dr. Whelan, you say in your paper that serious loss by leaching may occur under conditions of heavy rainfall and although a vegetative cover lessens this tendency considerable amounts of nutrients are unavoidably carried down below the level of root action. Can Dr. Whelan tell us at what level nutrients can be taken up by the Rubber roots ?

Dr. Whelan.—I would say that the majority of the feeding roots occur in the first foot or so of the soil.

In reply to a further question as to why green material is placed at the bottom of the planting hole if the root action is confined to the uppermost foot, Dr. Whelan replied that green manure should not be put at the bottom of the hole, but mixed with earth throughout the hole.

Mr. Keiller.—There is a tendency now-a-days when discussing organic and inorganic manures to refer as " organic " to mixtures of what Tea people know as the late Joseph Fraser's 840 lbs. per acre mixtures. Such mixtures are compared with purely inorganics as if they were all organic, whereas they are really mixtures of the two types. It gives rise to a very great deal of misunderstanding.

Mr. Murray.—It is not easy to sum up this discussion, but I will refer to some of the points raised. A question has been asked with regard to the putting of green manure in the planting hole. It is a great mistake to put a large bulk of green material into the bottom of a hole, and it will lead to backward development of the

plants. If green manure is put into a hole it must be mixed with the soil in alternate layers. With regard to the use of calcium cyanamide in the planting hole and the possible damage to the young plants, I remember this question was raised at the last conference. The conference was certainly not unanimous on the subject because I expressed the definite opinion that no harm was done if the fertiliser was properly mixed with the soil. It may scorch the plants when not properly mixed.

I think the outstanding fact which emerges from the paper and the discussion is that at the present time we know very little of the manurial requirements of young Rubber and there is considerable need for a great deal of experimental work. In our present experiments we are getting somewhat contradictory results and sometimes no response to manure at all. The absence of response to manure may be due to either of two factors. It may be that the plant does not want any extra food or it may be that the quantities used are too small. I do not think the latter is the general explanation, for in Malaya remarkable responses have been shown to small applications, usually of phosphate. The greatest need is for more field experiments. We have a number of experiments in progress on our own land and I hope estates will also undertake trials with our co-operation.

PLANTING AND MALARIA IN CEYLON

R. SVENSSON
Medical Officer
(Malaria Control Scheme)

THE advantage to an estate of possessing a stable and contented labour force needs no elaboration before this assembly. The health of the workers is now known to be an economic factor of first importance and its betterment is as much a matter of business as of philanthropy.

Malaria transcends all other diseases in its crippling effect on labour and its prevention is of primary importance in that its debilitating influence paves the way for the inroads of all other diseases. It is a proved fact that a diminution in the incidence of malaria is accompanied by a fall in the general morbidity from other causes.

Various systems have been tried for the breaking of the cycle of transmission of the parasites from Man to the Mosquito and back to Man again. One system aimed at raising Man's resistance to invasion by the parasite by a general improvement in his standard of living in such ways as better food, better housing and better medical attention. It has only succeeded where a concomitant improvement in agriculture has had an adverse effect on the breeding of the mosquito.

A second system seeks to eliminate by drugs all the parasites existing in a community and by so doing to break the chain of transmission. This is a method which has been given a thorough trial. It fails because it is in practice impossible to bring every member of a community under control by drugs. It rouses antagonism and is, moreover, definitely more expensive than the third system, which is directed against the mosquito.

If the number of carrier mosquitoes be reduced below a certain level (the level at which the rate of infection falls below the rate of recovery) malaria will die out in a community. This can be brought about by preventing the breeding of the mosquito within a radius of half mile of dwellings, the so-called control of malaria by anti-larval methods. The fact that the carriers of human malaria are invariably anopheline mosquitoes is a matter of common knowledge, but it is not so generally appreciated that out of the many species of anopheline in the world only a few are carriers of importance under natural conditions; in Ceylon, for instance, out of 18 species of anophelines only one, Anopheline culicifacies, has been proved to carry malaria. It follows, therefore, that in the attempt to control malaria we can economise energy and resources by concentrating the attack against this one species and for this purpose a knowledge of its habits is essential. Its favourite breeding place is in the pools, backwaters and edges of streams where the current is reduced to a minimum. It is a lover of light and a shallow sandy bedded pool in the open sunlight is a typical nursery.

In the dry zone of the Island conditions are suitable for its propagation over long periods each year. Here it is firmly established, making free use in addition to the streams of subsidiary breeding places such as wells, quarry and borrow pits ; in fact of any collections of still clean water exposed to the light. Malaria, in consequence, is highly endemic in the dry zone.

In the wet zone, however, Anopheline culicifacies is not so securely entrenched as in the dry zone. In years of normal rainfall the river beds are not exposed long enough for the mosquito to breed in dangerous numbers. It requires, in fact, a drought of two or three months' duration to produce the conditions requisite for an epidemic. The records of the years 1934 and 1935 reveal the disastrous possibilities of the failure of two successive monsoons.

This is, in brief, the picture of malaria as it exists in this Island in the stabilised conditions of to-day. As many of you are aware, the early " opening up " phase of planting was attended by serious outbreaks ; so serious in certain cases as to interfere with the progress of work.

Several causes conspired to increase the incidence of malaria. The felling of jungle let in the light upon the streams and the

blocking of the channel with fallen boughs multiplied the number of pools suitable for breeding. Stump holes, planting holes and silt pits all helped to swell the culicifacies population and the new gangs of "unsalted" labour fell ready victims to the unrestricted transmission of parasites that then occurred.

In recent years these matters have again come into the limelight, since the processes of re-planting have, in a modified form, reproduced the conditions associated with "Opening up." Broadly speaking, the Ceylon Planter is faced with the problem of preventing contact between his labour and Anopheline culicifacies, which is primarily a breeder in pools exposed to the light in the beds of streams. I propose now to consider various ways of effecting this.

One finds, almost without exception, that spleen rates diminish as one recedes from the main streams. In the prevention of malaria, therefore, the control of breeding in the larger waterways is a matter of first importance. This fact was recognised in the earlier days of your Control Scheme, but the cost of oiling the major streams was beyond the means of estates and your then M.O., Lt.-Col. Clemesha, was constrained to attempt control by drugs, the limitations of which have been demonstrated by exact experiment in more recent years. The disastrous epidemic of 1934-35 led Government to take in hand the stupendous task of the control of the main rivers and streams and by agreement reached last year with the C.E.P.A. Malaria Control Scheme they have undertaken to control streams down to 10 feet in width, wherever their organisation permits, even when such streams affect an estate population only.

Oiling is the measure on which Government must perforce rely in the main, and it is obvious that the formation of an efficient oiling organisation and its extension to all areas where estates are found must be a process extending over years. Estates, then, in all areas cannot immediately rely on the complete control of that factor of primary importance the main stream and would be well advised to take full advantage of the fact noted above that distance from the main stream diminishes spleen rate.

Site Selection

Regrettably little use has yet been made of the fact that distance from the source of breeding confers freedom, relative or absolute,

from malaria. In earlier days, in the absence of any knowledge of the habits of Anopheline culicifacies, the natural tendency was to choose sites for lines and factories near to streams where malaria is most intense. In the light of our present knowledge the time has come when the malaria factor should be the first consideration before erecting new lines or, indeed, re-conditioning old ones.

The ideal is, if possible, to find a site quite free from malaria where no control work will be needed; failing this, to choose one where the expense of control is minimal and to concentrate the labour upon it, rather than to dissipate them into a number of small colonies each requiring its half-mile zone of protection.

Healthy sites are usually high up on a ridge and difficulties will arise in the supply of water.

It will also be objected that the labourer must live within easy range of his work.

These objections are not insurmountable, and the fact must be borne in mind that the saving on day's work lost and on medical expenses will, in highly malarious regions, more than balance the cost of a pumping scheme and the transport of labour to and from work by lorry. One should avoid, as far as possible, the need for control, but in the vast majority of cases a certain amount will be necessary, so that we may now take stock of our armament.

The main stand-by is oiling which, as we have seen, is the basis of Government's control of the major streams. I do not propose here to detail the technique of oiling but will only say that, properly carried out, it has proved a rapid and reliable method of control and is the one on which we must chiefly rely.

It is, however, expensive and, in consequence, search is continually being made for other and cheaper methods that can efficiently replace it. Of these two are at present under trial in this country, flushing and shading.

Flushing

It is a matter of common knowledge that malaria in the wet zone varies inversely as the rainfall; that is to say, the higher the rainfall and the more frequently the streams are flushed by spates, the more larvae are killed and the less the malaria.

Flushing is an attempt to reproduce these spates in times of drought by damming the streams and releasing the collected water at intervals, either by means of automatic siphons or hand-operated sluice gates. The method is excellent in theory, but one finds in practice certain difficulties associated with the climate.

The beds of the hillside streams in Ceylon are perforce wide enough to accommodate a full natural spate, but in the drought many of them are reduced to a mere trickle meandering in the wide bed.

Various questions have now to be answered:—

(1) What is the minimum frequency of such artificial flushes that can be relied on to keep the stream free from Anopheline culicifacies?

(2) What is the minimum amount of water required for the efficient flushing of any given stream?

(3) Is the flow of the stream in a drought large enough to supply the amount of water required under heads (1) and (2)?

In the light of our present knowledge (or rather lack of it) there can be no doubt that the first stage of flushing any stream must be purely experimental. By means of temporary dams and sluice gates the answers to questions (1), (2) and (3) must be found before undertaking permanent work.

As regards siphons, judgment should at present be suspended. The ingenious type devised by my predecessor Dr. Macdonald is, after certain modifications of the priming pipes, working as reliably as one can reasonably expect. Its main faults are that it allows silt to accumulate in the reservoir and that its delivery in gallons per minute is too small.

At its present size it is suitable only for streams of a width that can readily be protected by shade, but when our knowledge of flushing is surer than it is at present it may be possible to bring a larger type of siphon back into use.

Shading

I begin my remarks on shading by trying to dispel a fairly common misapprehension.

Shading for anti-malarial purposes does not consist in merely cutting off from water the direct rays of the sun; it requires the

cutting off of light to a degree not yet definitely determined, but certainly greater than that given by the usual patchy jungle shade.

The shading of streams demands a continuous line of vegetation along both banks of wide enough spread to meet solidly over the centre of the stream, thereby putting the water into a tunnel of living shade.

To what extent this ruling may be relaxed is a matter for future trial and observation. Until further knowledge accrues we can only count on success from the heavy shade just described which limits us to streams of less than 6 ft. in width. There is, however, reason to believe that partial shade acts as a considerable deterrent to culicifacies breeding and it may yet be found that a selective intensification of natural jungle shade will increase the effective scope of this important and rather neglected means of control.

In both shading and flushing then we must feel our way cautiously and meantime rely on oiling as our weapon in chief.

Insecticide

To ensure that a film of oil is brought into contact with all the culicifacies larvae that are born in a drought is obviously a task that holds many occasions for error. Culicifacies adults are bound to hatch out for some time to come and, here and there, they will cause malaria. Fortunately her habits expose her to a second line of attack for, where she dines she sleeps, and she may be found gorged in the morning in the dark nooks and corners of a line room.

This is the time to slay her with insecticide before she rouses herself to fly back to the river to lay her eggs.

The spraying must be frequently repeated in order to deal with fresh batches as they arrive, but, luckily, it is popular with the labourers because it brings alleviation from other and more constant lodgers.

This, then, gentlemen, is in brief the problem that confronts us. As you can see much lies before us in the way of organisation and research. I am grateful for the support and co-operation that I have already received from members of this Association and trust that I shall continue to receive in the future that personal help and interest without which your Malaria Control Scheme cannot progress.

Discussion

Mr. E. W. Whitelaw.—I quite agree with you, Dr. Svensson, that in regard to the question of shading streams, results have not been satisfactory, but I do not agree with you that planters have not tried the method. They have tried it, but unfortunately the results have not been very satisfactory.

Dr. Svensson.—That is quite right. I should have put it that way.

Mr. Whitelaw.—I merely brought it to the notice of this conference as I have been to a number of estates where you have recommended shading, but the plants are not growing at all well. I think trees must be very carefully treated, first grown in nursery baskets, and then transferred. The method in use now is merely to take cuttings and stick them in at the side of streams and expect them to grow. This is doomed to failure.

Dr. Svensson said that he was much obliged to Mr. Whitelaw for having told them how planting should be carried out. He (the speaker) was ignorant of the proper plants to use, and of the correct ways to use them. He would, however, mention that the Rubber Research Scheme was trying out various plants at Dartonfield with the object of finding some plant that would give some shade under the existing Rubber shade. It was easy enough to get good shade in streams up to five to six feet wide in the open but what they wanted was some good close cover for streams under Rubber. Partial shade was not sufficient for anti-malarial measures. Complete shade was essential.

Mr. J. D. Farquharson said that he had tried spraying with insecticide to kill mosquitoes. Prior to 1934 by the method of spraying he brought malaria on his estate down to zero. During the epidemic of 1934-35 he realised that his labour did not contract malaria in the fields, but in the lines. He accordingly used that same method and sprayed the rooms and lines regularly and he was glad to tell them that once again he was successful in bringing malaria down.

As far as the planting community was concerned it seemed to him that the second line of defence mentioned by Dr. Svensson was really their first line of defence.

Mr. E. C. K. Minor.—As a matter of interest will Dr. Svensson please tell us what is the value of stocking wells and streams with fish?

Dr. Svensson replied that he did not think from the point of view of an estate that that would be of any considerable value. The fish required a sheltered life and more care and attention than could be given on estates.

Mr. L. B. Gourlay enquired at what distance round the lines malaria should be controlled.

Dr. Svensson replied that that would depend on the intensity of breeding. In ordinary circumstances one was safe within a radius of half a mile, but if the breeding were intense at the periphery this radius might need to be increased.

Mr. J. A. Mudge enquired whether the C.E.P.A. Malaria Control Scheme could arrange to prepare charts which would enable planters to diagnose the different species of mosquito. He thought that such charts would be of great value.

Dr. Svensson.—I am afraid identification is not so easy. I think the dangers of mis-identification might well outweigh any possible advantages.

Mr. R. C. Scott said they were all indebted to Dr. Svensson for his very interesting remarks. The Malaria Control Scheme had evolved a system of flushing streams by means of siphons built into walls of dams across the streams. Unfortunately these had not proved to be as successful as was hoped, as their action was liable to be interfered with either by silt blocking the siphons in times of spate, or by an insufficiency of water at other times.

At present Dr. Svensson was concentrating on the improvement of the siphon by incorporating the system which operated the tanks for flushing latrines. These tanks were perfect in operation and were splendidly made.

Mr. Scott then said that estates had co-operated liberally in the Scheme organised by the C.E.P.A., and it was equally necessary for Government to take their share in the control of malaria. He

was glad to learn that in the Kegalle district Government was co-operating well and were oiling streams.

He appealed to the Minister for Agriculture and Lands to control the breeding of anopheles in tanks which were scattered so generally through the Island. The question of the introduction of larvae-eating fish had been mentioned, and he hoped that something would be done to introduce such fish into tanks.

Dr. Svensson stated that about ten months ago the C.E.P.A. malaria authorities had a conference with Government and Government assumed responsibility for streams over ten feet wide. The point then arose how to get those streams incorporated in the Government oiling and they were asked to send in plans. Many estates had already done so. Already there were indications that Government's control of the larger streams was having a very beneficial effect.

SOIL CONSERVATION PROBLEMS ON SMALL-HOLDINGS IN CEYLON

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THE initiating and effecting of measures for the reduction of erosion and the conservation of the soil on small-holdings in Ceylon presents many practical problems. In such a short paper as this, however, it is not possible to refer in detail to all the varied problems which arise. I, therefore, propose to outline some of the numerous factors which have to be considered in this connection and to offer certain comments which I hope may have either a constructive or an educative value.

I will state at the outset that the term " small-holdings " is used to refer to areas of land, from one to ten acres in extent, on which may be grown a variety of crops including rubber. These areas may be isolated and surrounded by uncultivated land or may adjoin other cultivated areas under different ownership. It is with regard to effecting the measures necessary to reduce erosion, conserve the soil and improve its fertility that the various points referred to will be considered.

The great majority of these small-holdings vary in size between two and five acres and they grow, or are intended for the growth of, a variety of crops including tea, rubber and coconuts, miscellaneous seasonal crops and various minor crop plants, such as arecanuts, jak, citrus and other fruit plants.

Most of these lands are owned by local peasant proprietors who either reside on the land itself or live in the vicinity, and to whom such lands do not usually constitute their main or only form of livelihood. In planting districts their owners commonly engage in other part-time occupations, often tapping or other estate work, and they are unable therefore to expend the whole of their time or much money over the improvement of their own lands.

One of the primary problems in effecting the adoption of soil conservation measures on these lands, is to persuade the proprietors of the necessity for such work and the advantages gained from the expenditure of time or money entailed by their adoption. To some extent this can be done by personal approach of a tactful and sympathetic character, by persistent propaganda to stress the fact that erosion *is* taking place on the land, and that the conservation of the soil in the long run is a remunerative method of improving the soil and of obtaining bigger and better crops. This work often involves making innumerable visits to the man and to his land, in order to meet the owner in person, to point out where and why erosion is taking place, and to actually demonstrate to him how to prevent or reduce it. A very great deal can be achieved in this way, and, as is only natural with those of limited means, the protection and improvement of their land can be considerably expedited by a reasonable monetary grant, payable when all the necessary soil conservation works have been completed throughout the area. It would take a considerable army, of the right type of men, several years to assist every small-holder in the Island in such a manner, apart from the very justifiable expense that proceeding would involve. An unofficial, trained, civil soil conservation corps could also achieve appreciable results in this direction.

As in all forms of education, there are two principal methods of instruction by precept and by example, and the latter is a very potent factor in bringing home to small-holders the value and the utility of soil conservation works. There is much in this way that estates and the larger landowners have done and can still do to set an example by the adoption on their own lands of simple soil conservation measures to encourage "farming over the fence." I am able to state, from what I have seen in the last few years, that in this way there has been an increasing spread of soil conservation works to adjacent lands and this is continuing to take place; not only from the larger properties to small-holdings, but also *vice versa*.

The particular principles which are regarded as of primary importance in conserving the soil of any area of cultivated land in Ceylon from erosion by surface run-off, are threefold. The first is to exclude from the land, or, if there is no alternative, to collect and remove under proper control through the land, all surface run-off

originating on or coming through the adjoining land. In other words, to limit the quantity of run-off that has to be dealt with to that originating on the land itself, on the principle of looking after your own land and water and expecting others to do the same to theirs.

The second is to prevent, so far as is possible, the exit of surface run-off from the land itself in any way or in any place where it can cause damage to adjoining property, and to prevent this water taking with it any appreciable amount of soil material.

The third principle, and one which goes a long way towards safeguarding the last point, is to ensure that any surface run-off on the land itself either moves slowly or its movement is checked, and that this water is collected and safely removed sufficiently frequently to prevent it picking up and removing any appreciable amount of soil material.

These three principles sometimes present, on small-holdings, acute problems which are neither so common nor so pronounced on larger areas of land. These difficulties are due, in the main, to the limited surface area and to the unnatural or man-determined boundaries which, unfortunately, remain a characteristic feature of land division and settlement in the past.

The volume and the intensity of the rainfall in Ceylon, in the drier parts of the Island as well as in the wetter, are such that a considerable portion of this rainfall becomes surface run-off water. This run-off is often so flashy that it is rarely seen and appreciated, especially on land under cultivation whose vegetative density is often variable and is usually less than it is under natural conditions. In view of this, on any land subjected to erosion through changes in its vegetative cover, it is necessary to limit the movement of the run-off, even on flat land, by collecting it and removing any excess under proper control. On land with any degree of slope, it is the distance water moves and the rate of its movement, which contribute mainly to its eroding power; thus the steeper the slope of the land the more frequently up and down the slope should the movement of surface run-off be limited, and any excess collected and removed.

The only lines across sloping land in which the interval between them decreases regularly as the slope increases and *vice versa*, are

contour lines, which are, therefore, the only correct lines along which to site soil conservation works to limit and check the movement of surface run-off water, and to collect and bring it to a standstill.

The various types of soil conservation works are well-known, and I consider, where their excavation is possible, that contour drains with low, vegetated, ramp-bunds along their upper sides, definitely provide the best means of effecting the objects stated in the foregoing.

Other types of soil conservation works and measures are sometimes necessary and there are many factors which influence the choice of the particular type of work, or combination of soil conservation measures, which it is most appropriate to recommend for adoption on small-holdings. Some of these factors, which may be conveniently grouped under the following heads, are indicated hereunder :—

(*a*) **Climatic Factors.**—The chief of these are :—(i) *Elevation.* This limits the types of soil-conserving plants, affects soil temperature, the decomposition of organic matter, the character of the soil, and the removal of surplus water. (ii) *Rainfall.* This factor, according to its distribution, intensity and intermittance, determines very largely the type of conservation work desirable according to the necessity or desirability of retaining more or less water on the land. (iii) *Wind.* The disposition of the area according to its exposure to wind, and the prevailing type of seasonal winds experienced, as well as the degree of protection already established, may vitally affect the degree of protection necessary for both the soil and the crops. (iv) *Sunshine and Cloud.* The prevalence of one or other of these two factors, and their effect on the crops being grown, may determine to a great extent the degree of protection that can be afforded to the soil by different types of vegetation.

(*b*) **Topographical Factors.**—The main factors which require to be considered under this head are :—(v) *Position.* The position of a small-holding with regard to the adjoining areas of land and water is often a critical and determining

factor in deciding what form of soil-conserving measures are necessary and practicable. It is this factor which determines to what extent a land receives run-off water from neighbouring areas, whether the safe removal of the surplus is possible or not, and whether the land is subject to floods, and their duration. Other points which this factor affects are the depth and type of soil, presence of rock and stone, the height of the water-table, and the character of the sub-soil water. (vi) *Slope.* The degree of slope of an area of land, the length of the slope, and the uniformity or irregularity of its contours, are points of great importance, since they alone very largely determine the volume of the soil conservation works necessary to protect the area effectively, and thus the cost of the work. (vii) *Shape or Size.* The size and shape of a small-holding becomes of increasing importance as regards soil conservation, particularly as its area diminishes and according to the necessity for protecting it from various external influences. These include wild and domesticated animals, theft, trespass, and invasion by external vegetation and water. Another important point which is often considerably affected as the size and shape of the holding varies, is the extent to which this influences the presence or absence of natural drainage lines on the area.

(*c*) **Cultural Factors.**—This group embraces a number of considerations which may vitally affect both the type and number of the soil conservation measures that can be adopted. They include (viii) *Soil.* The type of soil, its depth, its organic matter and other colloidal content, its absorptive capacity, its porosity, and the degree to which it has been either eroded or leached in the past, are all factors which exert a considerable influence over the degree of protection that can be given this soil in the immediate future. (ix) *Natural Vegetation.* The endemic vegetation of the area, both past and present; its density, the degree of equilibrium which it has established, and the period during which it has been in existence as well as the extent of interference to

which it has been subjected, are all factors which have a definite influence over certain soil-conserving measures, especially as regards the rapidity with which suitable ground covers can be established. (x) *Cultivated Crops.* The crops and green manures or shade plants which have been cultivated in the past, are at present established or will be in the future, their type and the period for which they have been grown, and the method of planting, have an important bearing on the type and diversity of the soil conservation works and measures that can be recommended for adoption. (xi) *Cultural Treatment.* The methods and degree of cultivation and manuring carried out in the past or to be undertaken in the future are also matters of considerable importance in deciding the type of soil conservation works and those auxiliary measures which are most suitable for adoption on any particular area of land. (xii) *Irrigation, Drainage and Soil Conservation Works.* The type, the extent and the number of such works which have been constructed in the past, or which exist on the area when the conservation of its soil comes up for review, sometimes materially affect the extent to which improved methods of soil conservation can be adopted and the type of work that is practicable.

(*d*) **Economic Factors.**—This category embraces a variety of all-important factors, such as (xiii) *Finance.* Whether any capital is available, its extent and the degree or periods of its availability are primary factors in the development and protection from erosion of any area of cultivated land. Where capital is not available, the extent of State assistance that can be obtained, the method of obtaining it and the period or extent of work for which it is granted are points that require careful consideration. By no means of least importance are the maintenance costs of soil conservation works and how soon expenditure on them will be necessitated. Especially should these factors be considered in relation to the rapidity with which cash returns become available and the probable amount of these returns. (xiv)

Labour. Whether the holding is worked entirely by the owner, whether his work is whole-time or part-time, and what means of subsistence he and his family have during the lag period between the planting and harvesting of food crops. These are points of importance that must not be overlooked since they vitally affect the rapidity with which the necessary soil conservation works can be completed. If, on the other hand, some labour can be employed, the amount of labour available, the type of labour, and the periods during which it is available similarly affect the rate and quality of the work. (xv) *Time.* As already indicated under several of the foregoing heads, the time factor is a most important one, since upon it depends the reduction to a minimum of all losses both of soil and tardily recoverable fertility, as well as by the reduction of the non-remunerative period and hastening of economic and practical fruition. Under this head also may be considered the accessibility of the land to labour and for the easy removal of its products. (xvi) *Type of Farming.* This is another economic factor which is deserving of more recognition than it usually receives. Based as it is upon the old adage of not putting all the eggs in one basket, it is also a *sine qua non* of soil conservation that the land should be densely clothed with a mixture of utilities: fodder for man and beast, the too often wasted products of which, after passing through the natural factory of the domesticated animal and bird, should be continually returned to assist in re-clothing and improving the soil that produced them: in other words, intensive and mixed cultivation, one of the highest forms of agriculture.

(*e*) **Human Factors.**—Under this head come a number of factors which exert a very definite influence over the quality and quantity of the soil conservation measures effected, as well as over the rapidity with which the work is done, its propaganda and educative values, and the attachment and sense of security which it evokes. The most important of these factors are (xvii) *Physical.*

A man cannot be expected to do good work and labour long hours if he is not well fed, and moreover properly fed with a well balanced nutritious diet. Erosion renders fertile soils infertile, and poor soils produce poor crops and foods deficient in nutritive values. Soil erosion works in a vicious downward spiral, rushing down the path of least resistance. Soil conservation tightens up the springs and forces them into the contour lines which break this downward tendency; properly applied, it gives the soil that balance and equilibrium which is essential to the production of good crops and nutritious foods. In the case of small-holdings, particularly those on which the peasant proprietor is dependent either wholly or in part for his daily food, this matter is one of much more vital importance, both to the State and to the community as a whole, than it is in the case of large properties producing inedible commercial products.. (xviii) *Mental.* The possession of a certain degree of intelligence and character is necessary to appreciate both the immediate effects and the long-range results of the adoption of soil conservation measures, whatever the standard of education that may have been reached. A definite type of mind and character is necessary, both in the adviser and the advised if the necessary degree of contact to effect progress in soil conservation work among small-holders is to be attained. The peasant proprietor and the small farmer all over the world exhibit a similar conservatism and reluctance to adopt new methods of agriculture or land improvement until they can see for themselves, on someone else's land, the benefits of the new system. Once the advantages of such changes are appreciated they are not slow by choice in adopting them, though there are always the unimaginative, slow-thinking few for whom the impetus of legislation is necessary to push them along the right path. The primary essentials in effecting advisory and educative work of this nature are personal contact, tactful and sympathetic approach and the creation of interest by knowing the work and

being prepared to explain, demonstrate and assist in it patiently. More has been done, is being done and can be done in this way than in any other. The Ceylon peasant is not slow to appreciate the value of soil conservation works, but his difficulties in effecting them as rapidly as is desirable are primarily financial, for he has to find the wherewithal to feed himself and his family during the period these works are under construction.

While this paper is perhaps more general than is really desirable for a rubber conference, it is hoped that it may at least present certain lines of thought which might be of interest to owners or managers of existing rubber areas ; and further that it may be of some utility to those who are at present getting a part of their land newly planted with rubber.

Discussion

Mr. W. I. Pieris (Smallholdings Propaganda Officer).—So far as soil conservation on Rubber smallholdings is concerned I would like to make a few remarks. The picture I would like to place before you is soil conservation on existing Rubber holdings as distinct from that on new planting holdings where the land is felled and cleared of jungle and you are free to do as you like without interference from trees. There are in this Island 97,000 Rubber smallholdings comprising a total acreage of 130,000. The question of soil conservation on these is not quite so straightforward as on land that is being cleared of jungle and planted anew. Most smallholdings are very closely planted and there is considerable difficulty in cutting contour drains without damaging roots and interference from trees. I agree with Mr. Lester-Smith that the best system for smallholders is bunded contour drains. It is easy to understand and comparatively cheap, but it cannot always be given effect to. There are alternatives. I have found stone terraces very useful and also the planting of cover crops. Establishing covers under heavy shade is not easy, but I have found that better growth can be obtained by opening shallow pits about 6 ins. deep and 3 ft. square between every four Rubber trees, filling them with cattle dung, leaf mould, etc., and

sowing the cover crop seed in them. We find that growth is much more rapid in these circumstances. Another outlet is afforded by replanting. As you are aware in most smallholdings the growth is poor and the tapping bad and replanting affords an admirable opportunity of obtaining a new stand of high-yielding trees with proper provision for soil conservation. I cannot go so far as to agree that the earth from contour drains should always be put on the upper side of the drain. Our experience in the Kalutara District, for instance, where we have heavy rain and Rubber is planted on steep slopes, is that it is not always possible to put the earth on the top side because it gets washed back into the drain. Therefore, where the gradient is steeper than 1 in 10, we recommend that the earth be put on the lower side.

The money factor is undoubtedly one of the main limiting factors with the smallholder and a monetary grant, where possible, is most helpful, but the full cost of the work should not be paid. I find that even a poor man appreciates a thing more if he is made to contribute something towards it himself. With perseverance and tact and the correct type of officer, much useful work can be done among smallholders.

Mr. Lester-Smith.—The problem is undoubtedly one of some difficulty as far as smallholdings are concerned. It must be proved to the smallholder that the conservation of the soil in the long run is a remunerative method not only of improving the soil, but also of obtaining better and bigger crops. It would often involve making a large number of visits to the man and the land. A very great deal can be achieved in this way. It is said that the smallholder is very conservative. This may be true, but I think that if he is approached with sufficient perseverance and tact it is possible to make him realise the advantages of soil conservation.

Dr. R. V. Norris.—We have heard of the excellent work that can be done on smallholdings in the matter of drainage. On many such holdings, however, there is no natural outlet and the water has to drain away to the paddy fields below.

Mr. E. W. Whitelaw.—I quite agree with most of the remarks made by Mr. Lester-Smith and I have not the slightest doubt that, if properly handled, smallholders can be made to conserve their soil.

I wish to draw your attention, however, to another point. I think many of these smallholdings are doomed to utter failure if budgraftings are used. Budded plants need very special care and continued attention if they are to develop satisfactorily, and I doubt whether the average smallholder will exercise the necessary care. I cannot help feeling that we will be doing these smallholders a great disservice by giving them budgrafts. What I think they should be given is good seed from good stock—preferably clonal—which will be much easier to grow. In the end this will give them good yields—perhaps better than from poorly grown buddings.

Mr. F. de Saram.—Smallholders must be instructed in the matter of replanting. I have seen clearings in various conditions and situations and I think that some of them have no right to be planted at all. Some places were hardly accessible and in one place there were pools of water intended to mark the budded plantations.

Mr. Lester-Smith.—I agree with Mr. de Saram as regards the question of accessibility. In some places it is terrible, but this is the land which belongs to the villager.

Mr. A. H. Healey.—Has the use of clonal seed been considered in the case of smallholdings? It appears that TJ. 1 gives good seedlings. It seems to me that it should be available in large quantities in Ceylon.

Mr. Pieris.—I think it should be the duty of the Smallholdings Department to see that smallholders' buddings *do* grow properly.

Mr. W. P. H. Dias.—There are over 2,000 acres of land given over to villagers just behind my estate. I went there a few weeks ago. I cannot understand how they are going to plant these with budded plants. Unless the Rubber Research Scheme comes to their rescue and gives them plants it would be a very difficult matter for them.

Mr. Lester-Smith.—Villagers are not obliged to provide themselves with budded plants. The New Rubber Planting Scheme is to provide them with free budwood.

Mr. Dias.—Last year in July and October I wanted Rubber seed—lots of smallholders too wanted seed and they were sold at 60 cents a thousand. I examined some of the seed and was of the

opinion that not more than 70% would germinate. The smallholder must be given good seed.

Hon'ble Mr. D. S. Senanayake.—Some questions have been raised which relate to the policy of the Department over which Mr. Lester-Smith has not got the deciding voice. With regard to the policy itself I am responsible, and if there is anything wrong with the policy I shall only be too happy to be corrected. I had no intention of speaking but having heard the questions put to Mr. Lester-Smith and seeing that he was heckled I wished to say a few words.

With regard to the system of soil conservation methods, and in connection with the question of asking smallholders to put earth on the top side of the drains, I would say this. I know that when land is too steep that method is not satisfactory, but I do not want lands that are too steep to be opened up at all. We want to assist people where land is suitable, not where the land is too steep and where the soil would be washed down ! I was very interested to hear that there is legislation in certain parts of the world to prevent any land over 40° slope being opened up. We have a general order in Ceylon prohibiting any alienation of land belonging to Government that is above 45°. But it is quite obvious from experience that legislation would be better than general orders.

With regard to the question of seed itself, I am glad to note that Mr. Dias had tried to interest himself in the smallholder. I also noted what he said about the seed sold and his statement that barely 70% would germinate. I was glad to hear that remark because I have something to say about it. We tried to get good seed to be supplied to these smallholders. There were some who were very generous and who offered to give us seed. Some of the tenders sent to me were very high and, of course, I suggested that the villager may be helped by Inspectors in trying to get seed from estates close by. I actually suggested this because I thought it would work. It is our intention to insist on people budding Rubber in the first instance. We insist on this being done and it is our intention to supply them with budwood and then provide them with budders.

With regard to the point raised by Mr. Whitelaw that many of these smallholdings would be doomed to failure if budgrafts

were used, I am afraid I find it difficult to understand his attitude. I know that Mr. Whitelaw is an enthusiast on the subject of budded Rubber and I wonder why he opposes the use of this material by smallholders. I have not the slightest doubt that he has the best intentions, but I find it difficult to grasp his reasons. It should be our endeavour to give the smallholder the best yields possible. That is the policy I have before me, and that is the policy I will continue to adopt.

I will finally draw your attention to the remarks made by the Chairman at the beginning of the conference. We are far behind Java and Malaya in the question of replanting. We should start at once to replant our land with the best material available. It is for the purpose of encouraging replanting that I decided to issue coupons for areas cut out for replanting. I advocated this in connection with the Restriction Scheme and even if I am wrong I honestly feel that that is the best policy.

Mr. Whitelaw.—I would like to say a few words in answer to Mr. Senanayake, as I think he has misunderstood me.

Firstly, my suggestion that the smallholder should use clonal seed and not budgrafts emanates from no other motive than a sincere desire to see the villager ultimately own something worth having. After inspection of some 200,000 budgrafts on Company-owned estates, where they generally had every possible attention, I found that at seven years only 53% of them had matured properly.

I do not doubt the villagers' capacity or intelligence, but there is so much that can go wrong with a budding if it is left unattended that I feel he will make a grater success of the more easily grown clonal seedling, which will give him yields not far short of those obtainable from well-grown buddings, if they are short at all. In fact many Companies further East prefer clonal seed to budgrafts.

I hope Mr. Senanayake will realise that my suggestion has nothing behind it but a *bona fide* desire to help the villager and not obstruct him.

Chairman.—I would like to announce that a cablegram has been received from Mr. T. E. H. O'Brien, Director of the Rubber Research Scheme, wishing the conference all success.

OIDIUM IN RELATION TO REPLANTING IN MID-COUNTRY

D. C. GORDON-DUFF
(Warriapolla Estate)

Introductory

FOR the purpose of this paper I propose to define mid-country rubber as 800 feet elevation to 1,500 feet. There are naturally cases in which Oidium will affect replanting below 800 feet and there are favoured cases where replanting above 1,500 feet may be an economic proposition.

Provided the cost is ignored rubber can be grown almost anywhere, the advisability of replanting any given area on a commercial scale must always turn on the basic factor of economics, and the probable return on money invested. At the outset I must say that I am convinced that Oidium alone, is a factor which should not deter anyone from replanting old rubber in mid-country zones as defined above.

Unfortunately, so far as I know, there are no mid-country areas of replanted rubber, budded or clonal seed, presently in commercial tapping. The majority of this paper must, therefore, be left in the realm of speculation, on the other hand, arguments against replanting must also be in the same category.

General Considerations

Oidium as a disease is a menace, but it is not by any means so lethal, as for instance, *Fomes lignosus* or *Fomes noxius*, to mention only two root diseases. Being confined to above ground it can

be more readily seen, and more easily combatted. It is defined as a mildew, and infection is spread by air borne spores. To date control measures have been directed entirely on these lines.

The general inference is that Oidium is a hibernating fungus, which rests somewhere in the terminal shoots of the rubber tree. This would account for an attack of old rubber becoming evident over a wide area, at one time, rather than spreading from one focal point. Microscopical examinations have not, however, yet revealed that Oidium is a hibernating fungus ; at no stage has examination shown a resting spore during its life history. My authority for this statement is the Malayan Rubber Research Journal, and it would appear to be a very important point for the scientists to investigate.

It is an undoubted fact that mid-country rubber starts at a disadvantage when compared to low-grown rubber. Temperatures and rainfall conditions are not so favourable ; the vigour of the tree is less, its resistance to disease of the nature of Oidium is probably less ; and its recovery from attack, owing to unfavourable circumstances, must undoubtedly be slower.

Wind damage must be borne in mind when selecting a suitable clone for any area, together with soil and rainfall conditions. In the earlier stages of the plants growth, from what I have seen, I am inclined to think that wind damage is a greater menace that Oidium, and far more difficult to combat.

In Malaya the extent of replanting is rather more than in this country. From reports collected from various estates the Rubber Research Institute of that country are now in a position to advise what clone is suitable for individual areas. It is to be hoped that estates in this country will co-operate, and that our own Research Scheme will soon be in a position to give equally good advice.

The discovery of a clone, preferably high yielding, naturally resistant to Oidium, is the ideal for which all Rubber Planters are seeking. For my own part I feel that its discovery, in this imperfect world, is unlikely. Certain clones more or less resistant to Oidium are, however, likely to be found or evolved by geneticists.

Effects of Air Currents.—The spread of infection is by air-borne spores. Thus wind is a matter of interest. In general the worst of the Oidium season falls during the North-east Monsoon. It is natural to suppose that old infected rubber in close proximity to a replanted area, in a north-easterly direction, will cause infection in the new area ; and if there is no old rubber the converse occurs. From my own observation this has very definitely been carried out on at least two spots. In one there is practically no rubber between a 10-year-old clearing and a large belt of jungle to the North-east. This clearing is reported to have been almost free of Oidium and I certainly saw very few signs of disease. In the other case it was even more marked. To the North-east was a strip of paddy field and then more clearings of another estate. During the North-east Monsoon no Oidium was observed ; when the monsoon changed, blowing from old infected rubber in a large area to the South-west, and next to the clearing, infection immediately appeared. It should be noted in this particular case, the period of activity was unusually prolonged, owing to weather conditions favourable to Oidium.

The distance which bad Oidium infection will travel is rather limited. I am aware that the disease has spread all over the Island, but the rate of spread was not very rapid, particularly at elevations below 1,500 feet.

The conclusions I have arrived at are :—Replant areas which have least source of infection on the North-east side since the prevailing wind is from that direction during the Oidium season. Replant in one large block rather than several small ones.

Age Factor.—Oidium did not become a menace to rubber until the trees were, generally, of a considerable age. It is now an accepted fact that the economic life of a rubber tree is limited, whether, or not, it is affected by Oidium. Trees that are generally debilitated are more liable to infection. This is borne out by the fact that the less robust mid-country rubber is the first and worst sufferer from Oidium. I do not think that anyone will deny, that apart from dusting or other control measures, old and maltreated rubber is more affected than that which is in good heart. There-

fore the age factor in relation to Oidium must be taken into account, and this is one which we cannot alter, other than giving the crop economic care.

Manure Applications.—The nutrition factor is a general one in relation to Oidium. The danger period lies between the time when new leaf appears and is matured. Manure, particularly nitrogen, by improving the general vigour of the rubber tree, makes it capable of putting out, and maturing the leaf in a shorter time than unmanured areas.

Normal manure applications alone have not shown themselves able to prevent Oidium. Used in conjunction with a fungicide they are, however, of very great value, the growth of the tree is considerably stimulated and the danger period between the appearance and setting of the new leaf is reduced; and should the tree be defoliated by disease, it is in a better condition to put out another crop of healthy leaf.

Figures were compiled recently, giving an account of the amount of nitrogen content in the leaf-fall of old rubber. The total per acre was surprisingly large. If retained by the soil the leaf will, eventually, rot and some of the nitrogen again become available to the tree, but not at the moment when it is most required, the refoliating period. Experiments to determine the most suitable time of application, and quantity of manure applied, should yield valuable data. Old rubber which has been untapped and unmanured for any considerable length of time is less affected by Oidium, than manured and tapped areas. Similarly trees affected with Brown Bast in advanced stage carry an excellent head of foliage. These trees are probably not tapped but even if they are, they yield no latex. The removal of latex appears to have a very debilitating effect upon the tree, manuring does not appear to compensate for this loss.

Weather.—Weather conditions during the Oidium season are one of the main factors bearing on the intensity of the attack. The weather unfortunately cannot be controlled, but use can be made from observation of temperatures and humidity conditions, and control measures can be adjusted to suit these.

Beeley has recorded the optimum temperature for development of Oidium at 56-62° F. and the humidity at 75-80 per cent. During the 1939 refoliating period weather conditions in the Low-country were peculiar, Mr. R. K. S. Murray's article on this point is very instructive on how to utilise observation of climatic conditions. In particular I would draw attention to :—The conditions relating to the quick maturing of new leaf, *i.e.*, bright weather, and water supply to the roots, and secondly the necessity of elasticity of the control programme, with an adequate supply of material.

Very young plants are liable to be attacked and naturally they have not much resistance to the spores, fortunately on account of their size they are easily dusted or sprayed, and do not require large quantities of material to keep them free from attack. Wind is a general factor not only from the point of view of conveying spores, but also from the point of destroying the vigour of growth. Until plants have grown sufficiently to give each other protection from wind damage, this, particularly if combined with dry weather, is a very severe handicap to good growth. In bad cases foliage is largely blown away, and the remainder very lacerated. The plant is debilitated and laid open to attack by Oidium.

Planting of Clones.—Individual trees of a clone are reputed to winter at the same time. If this is correct the planting of mono-clone blocks should simplify control measures very considerably and very largely reduce the cost.

Methods of Control

At present there are three main lines of defence. Direct application of fungicide to the leaf, application of manure to stimulate growth, and the prevention of the spread of spores by wind breaks.

Fungicides.—Many types of wet fungicide have been tried out, some were successful, others not so good, but all, in older rubber, were too expensive in application and transport. Subsequently fine sulphur powder was tried out, so far, from the point of cost and effectiveness of control, this material has not been surpassed. There are plenty of improvements to be made in this material, from the point of quality and the addition of suitable " stickers." These being non-fungicidal agents, which help the sulphur to adhere to

the leaf while carrying out the fungicidal process. But, on the whole, sulphur is the best and most economical product presently known.

Comparative experiments were carried out last season with various brands of sulphur, the Research Stations have made fairly exhaustive enquiries about "stickers." The main trouble in regard to these is their cost. The war has, I fear, stopped any wide scale experiments on these lines. In practice I found that good results might be expected from the use of Beacon Curative and Preventative sulphur mixed with a sulphur powder of high sulphur content in the proportion of 1 to 3. The former has a very low sulphur content and a high quantity of mud. The mud appears to act as a sticker.

Manure.—As previously mentioned the application of normal doses of nitrogen, phosphoric, or potash, alone, or in combination have shown themselves to be unable to control Oidium. They can only assist the general vigour of growth.

Wind Breaks.—Oidium attacks only a few types of vegetation, the majority of trees are immune. It would appear that immune trees prevent the spread of disease, either by stopping the passage of spores, or actually killing them, the germinated spore being unable to penetrate the tissues. Again a point for scientific investigation as to the best type of tree and the number required. One case I know of, where alternate rows of old rubber were cut out and Grevillias were planted. When they got more or less the same height as the older rubber, despite no dusting very little Oidium was in evidence. To plant other trees to this extent is obviously uneconomic, but it does indicate that the judicious use of certain trees is likely to be of great benefit in the prevention of the spread of disease. The Rubber Research Scheme of Ceylon admit that Albizzias at 12 per acre can do no harm, and may give benefit.

I was informed a short while ago that Albizzias in some districts encourage Ustulina, I have myself never seen this, perhaps the Research Scheme may have information on this point.

I have noticed on one estate great benefit from a narrow belt of coconuts between old rubber and a clearing. On my own estate

I have found plants in cocoa, while still below the top level of the cocoa trees, to be quite free of Oidium.

Where soil conditions are reasonably good, I do not think that young Albizzias or Gliricidias have the least effect adversely on the rubber plant, there is plenty of food for them all. I am fully aware that this statement is not in accord with general ideas; on the other hand, I do not think my soil conditions are very outstanding, and I have seen no check to the rubber from Gliricidias or Albizzias in close proximity to the plants.

In the early stages careful use of erect cover crops can be of great help in preventing Oidium spores alighting on, and attacking small plants. They must not, however, be of such density as to reduce temperatures to the optimum.

Application of Dusting

In the very small stage the best and simplest form of dusting is probably by a jute hessian bag, shaken over the plant. Later a very efficient form of cheap duster can be made from a pair of hand bellows, after the nature of the one supplied by the firm of "Vermorel." These can be made by any intelligent estate mechanic and are suitable for use on plants, up to the age of two or three years. Thereafter something in the nature of the "Dry Mac" hand power machine, or even a power dusting machine is required.

The cost of dusting replanted rubber in its early stages is really very small, a large amount of sulphur is not required, and this is what accounts for most of the cost in dusting old rubber.

On present knowledge Oidium control has got to be practised more or less every year. To date the most effective and economic form of control is sulphur dusting. On that basis we must lay plans ahead.

Transport.—I am in favour of dusting by mechanical transport, therefore when replanting roads should be constructed with this object in view. Apart from this point good roads tend towards better supervision, and it is surprising to see how few roads are, generally speaking, put into replanted areas. They can be constructed cheaply so that the minimum loss in stand per acre is obtained.

Number and Rate of Application.—The maximum effect from sulphur dusting is, in my opinion, derived from frequent small applications, rather than less often with a larger dose. One supervisor can with a carrying machine dust say 100 acres in a full day. This is hard work for at least eight labourers and one supervisor. If mechanical transport is utilised on a well roaded area 500 acres can be dusted by one supervisor, one driver and one labourer in the space of four hours, with the minimum exertion. On nearly all areas there are a few spots which cannot be covered in this manner, a carrying machine is necessary to dust these places. This, however, is a very minor undertaking compared to doing the whole area.

In this way rounds, in unfavourable weather conditions, can be carried out, say every four days, with the minimum of dislocation to other work.

Dusting Machines.—There are many types of dusting machines on the market, some good, some not so good. The main essentials in a machine are that they will put the sulphur where it is required, and should be easily controlled. The majority of machines could be much improved from the point of ease of control.

Costs.—On the subject of cost of Oidium control. Since I know of no large replanted areas brought into bearing or near bearing I can only give indication for the first two years. In a bad Oidium district for the first two years, I put the cost of sulphur control at Re. 1 to 1·20 per acre per annum maximum. As the trees increase in size the amount of sulphur must also increase, but as I have tried to indicate in this paper :—

If the trees are in good heart and untapped they will recover from wintering quickly. The necessary dose of sulphur will be small ; and if forethought is used, application charges should also be small. In old rubber in one of the bad Oidium districts my maximum cost per acre was Rs. 4·53. When compared to, say, manuring costs per acre this is a very small price for healthy rubber.

Clonal Seed.—In connection with dusting, though somewhat outside the scope of this paper, there is the question of the production of clonal seed. If this is contemplated, the following must be borne in mind :—The rubber flower is the first to be attacked

by Oidium, there is no obvious sign of attack until the flower is dead. If valuable seed is to be obtained, control measures must be instituted as soon as the immature flower appears and continued, at least until the seed has "set."

Speculation

From the purely speculative point of view, are we working on the right lines? At present our measures are largely defensive and sulphur is only a palliative. We do not know if and where the Oidium hibernates, and cannot in consequence attack it at this stage. It is conceivable that it might be a deficiency disease and the application of something to the tree might give it resistance.

Can the scientists tell us exactly what is the composition of latex, and its function in the tree? Its removal appears to have a detrimental effect on the tree's resistance, to a greater extent than can be compensated by normal manure applications.

In the human system many widespread diseases are now controlled by some simple but revolutionary treatment, I see no reason why something should not be discovered to control Oidium.

Conclusion

In conclusion, I consider that Oidium is no bar to replanting in mid-country areas.

Chairman.—Mr. Gordon-Duff, who has prepared a paper on "Oidium in relation to Replanting in Mid-Country," is mobilised and unfortunately cannot attend. Mr. Whitelaw has kindly undertaken to read a summary of the paper and answer questions.

Mr. Whitelaw.—I am very glad to do this although my views on the practicability of replanting in the mid-country do not altogether correspond with those of Mr. Gordon-Duff.

Discussion

Mr. R. F. Bourne.—Have any experiments been carried out with manuring alone, without sulphur dusting?

Mr. Whitelaw.—Not as far as I know, but my general experience is that manure has no effect except that it helps the trees to recover more quickly.

Mr. Murray.—Eleven years ago we carried out manuring experiments in a badly affected area on a mid-country estate. The applications consisted of nitrogen and potash, separately and together. The applications were continued for two years in succession, but were found to have had no effect at all in checking the disease. Another experiment was made on a low-country estate five years ago and that was limited to one application. There again manuring had no effect at all in reducing the incidence of the disease.

Mr. G. B. Foote.—I have noted this year Oidium on an estate in Ratnapura where once there was no signs of this at all. It was in a 20-acre field planted half with seedlings and half with budgrafts. The estate was badly affected. During the sulphur dusting there was no leaf fall, but there were badly spotted leaves. That was my first experience of seeing Oidium in budded Rubber.

Mr. Whitelaw.—I also have had such experience. I should like to ask Mr. Murray if it is possible to discover a clone of high yield which will resist Oidium.

Mr. Murray.—This matter engaged the attention of the Rubber Research Scheme as far back as 1929, but no indications of resistance were found. We have now resumed the search for resistant trees and 34 estates in the Matale district are co-operating with us by marking any trees which show a notably healthier foliage than their neighbours. The idea is to have these trees under observation year by year and to see whether they show true resistance. I have recently inspected trees on two estates which were so marked last year, but am sorry to say that these trees appeared to be as badly affected this season as others. We have also made application to Government for a certain area of land for the purpose of planting a museum collection of clones to study reaction to Oidium. I have made a number of individual observations suggesting that some clones may be less susceptible than others and have also received such reports from Superintendents. I do not think it possible to develop any form of material that will be entirely resistant to Oidium. We may be able by selection or top grafting or breeding to make the attack less severe than it is at present, but I cannot hold out any prospects of achieving results within a short time.

Mr. R. S. Dalgety.—On page 136, Mr. Gordon Duff says : "In practice I found that good results might be expected from the use of Beacon Curative and Preventive Sulphur mixed with a sulphur powder of high sulphur content in the proportion of 1 to 3. The former has a very low sulphur content and a high quantity of mud. The mud appears to act as a sticker." Can you tell us whether further experiments have been carried out ?

Mr. Whitelaw.—I do not think so.

Mr. J. D. Farquharson.—Mr. Gordon Duff is of the opinion that Oidium did not become a menace to Rubber until the trees were generally of a considerable age. He also says that it is now an accepted fact that the economic life of a Rubber tree is limited, whether or not it is affected by Oidium. Can you say whether that is the general opinion ?

Mr. Whitelaw.—Possibly so.

Mr. P. R. May.—I consider that the planting of Albizzias too close retards growth. Is that correct ?

Mr. Whitelaw.—It definitely retards growth.

Mr. Bertrand.—I agree. I think it is a mistake to plant your Albizzias too soon.

Mr. Whitelaw.—That is a point I would like to emphasise.

PLANTING MATERIAL

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Introduction

IT is now generally accepted that improved yield per acre and hence more efficient production must depend to a very great degree upon the use of genetically superior *Hevea* trees. As a consequence much effort has been devoted to the improvement of planting material in the principal rubber-producing countries during recent years. Work of this kind has now a history of over twenty years, and I propose to commence my paper by reviewing the stages by which its present state of development has been reached.

History of Plant Improvement in Hevea

The first real step was dependent upon a satisfactory method of reproducing Hevea plants vegetatively. Once the technique of budgrafting had been perfected many of the best estate trees were propagated and hopes were entertained that the budded progeny would reproduce the high yields characteristic of their mother trees. Early test tapping results were disappointing and only a very few of the clones so established came up to expectation. The majority gave yields only slightly, if at all, higher than ordinary seedling rubber and many suffered more or less severely from defects such as poor or uneven bark renewal, liability to wind damage, and so on. The poor performance of these clones led many to the erroneous conclusion that the budgrafting method was a failure, and even to-day, the success achieved by many budded areas has not, I fancy, entirely removed the prejudice against the budgraft as a form of planting material. I shall take up this topic again later; for the present I would point out that the failure of

many clones may partly be attributed to the fact that until the progeny (seedling or budded) have been tested, it is impossible to disentangle the parts played by environment and by heredity in determining the yield of a tree. So it is probable that many selected mother trees derived their high yield from a favourable situation rather than good hereditary quality.

Most primary selection of trees for clone testing, though often conducted with care, depended to a certain extent upon chance observation of high yielders. Later, in a few cases, the search was systematised. In Java, for instance, the s'Lands Caoutchouc Bedjrijf (possibly better known as the "Government Rubber Plantations") had the highest yielding tree in every one of 5,300 tapping tasks recorded and kept under observation. By degrees the poorer trees were eliminated and eventually only the best 260 were chosen for test. Yet out of these 260 clones representing the cream of about a million and a half estates trees, only two (L.C.B. 510, and L.C.B. 1,320) have proved to be of sufficient merit to justify their recommendation for large scale commercial planting. Extensive systematic primary selection has been carried out elsewhere in the Netherlands East Indies and Malaya with like result, so that now the opinion is generally held that the likelihood of discovering clones which are superior to those now in use, by primary selection from ordinary seedling populations, is so low as to make the effort quite unwarrantable.

Further progress, then, must be dependent upon artificial breeding or selection from illegitimate families. Cross and self-pollinations had been made as early as 1919 by Heusser in Sumatra, but the fundamental importance of this work did not at first attract the wide attention it deserved and it was not until nearly ten years later that work of the kind was recommenced. During the late twenties a considerable number of legitimate families were raised by the research organisations and other concerns in the N.E.I. and Malaya and many have now been in test tapping long enough to make it clear that the average yields of the *best* of these "primary" families may equal those of the best "primary" clones. (By "primary" clones I mean clones established from ordinary estate seedling trees; and by "primary" seedling families, families produced by crossing "primary" clones or their mother trees).

As all know, there is a much greater variation between the yield of individual members of a seedling family than between individual members of a clone. This is due to the fact that the members of a clone all have the same hereditary constitution whereas the members of a seedling family are genetically variable ; in the one case environment (including influence of stock) alone is responsible for the yield differences observed ; in the other, environment and heredity together are concerned. Since environmentally produced " acquired " characters cannot be transmitted to offspring, improvement of yield by selective propagation within a clone is clearly impossible. In a seedling family, on the other hand, the high yielders will, on the whole, have an increased hereditary capacity for high yield and so by budding from them, clones of superior value should be obtained. This conclusion is amply borne out in practice. Clones, for instance, established from selected individuals of the legitimate families to which I have just referred are now in test tapping and the best of them are giving yields of a higher order than the best " primary " clones at comparable age. The exceptionally high yielding Clone A.V.R.O.S. 352 is one of these " second generation " clones, its mother tree being the best of Heusser's original cross pollinated seedlings. Another example is given by the new Prang Besar series. Illegitimate families also have been used as a source, A.V.R.O.S. 255, for instance, being derived from an open pollinated seedling of A.V.R.O.S. 36. Although many " second generation " clones have a tapping history of three or more years, in general the organisations responsible for their development do not yet consider them sufficiently well tested to justify their release for commercial planting.

The test tapping figures indicate that the best second generation clones are capable of yields considerably higher than the seedling families from which they were derived. Yet it is quite possible that the best families raised from crosses between "second generation " clones will be equal in yielding capacity to the " second generation " clones themselves. From selected individuals of these families " third generation " clones could be established and so the process of clone improvement would go on. As a consequence we should in the future have seedling families perhaps equal to, but never better than, the best clones available at the same time.

Crosses between " second generation " clones have already been made. Some families, descendants of Heusser's original crosses, have even come into tapping in Sumatra. Moreover, as it has been the practice for some years now to establish a few buddings from all the seedling offspring of a cross as soon as buds are available, a range of " third generation " clones derived from these families is in existence and are in tapping.

The present stage in development of *Hevea* planting material may be summed up as follows :—

(1) Expenditure of effort on primary selection from ordinary estate trees is no longer worth while, though the establishing and testing of clones from exceptionally outstanding trees of this class may be justifiable.

(2) Improvement at present depends upon the production of legitimate seedling families by artificial pollination and the testing of clones derived from these families and from illegitimate and isolation garden seedlings.

In concluding this section of my paper I would like to point out that future improvements in the yielding capacity of planting material are most unlikely to be of the same high order as the first improvements. The best proved clones may reasonably be expected to give yield increases of the order of 100 to 200 per cent. over the yields of ordinary seedling rubber; the percentage increase brought about by the best " second generation " clones over the best " primary " clones will almost certainly be much lower than that. And it is to be expected that with further progress, the degree of improvement achieved at each stage will become progressively lower.

Buddings and Seedlings as Planting Material

The problem of the relative merits of budgrafts and " clonal " seedlings has aroused considerable interest in the last few years and so I now propose to pass on to a consideration of this subject.

The term " clonal " seedlings is often applied rather loosely to seedlings of three distinct classes which differ in the certainty with which their parentage is known. These three classes are :—

(1) Illegitimate seedlings, of which the seed parent is known, but the pollen parent unknown.

(2) Isolation garden seedlings, which are mixed illegitimate seedlings with a limited range of pollen parents.

(3) Legitimate seedlings, of which both parents are known.

Illegitimate seedlings of certain clones, notably A.V.R.O.S. 163, have been shown in Sumatra to be capable of very good yields, but it should be emphasized that these yield figures only hold good for the particular unknown range of pollen parents represented. Seed of the same clone, but coming from a different area, with different male parents, would have a correspondingly different range of hereditary structure and would require separate test. In the absence of such tests the risk run in planting this class of seedling material is high, both in respect of yield and secondary characters.

Isolation gardens are areas containing a selection of clones intended primarily for seed production and planted at a sufficient distance from other rubber to eliminate the possibility of cross pollination with inferior genetic material. (Alternatively, the barrier against foreign pollen may be a large mono or polyclone block consisting only of clones represented in the garden). The number of clones planted varies. The earlier gardens established in the N.E.I. and Malaya contained a relatively large number, but in those laid down more recently there has been a considerable reduction, several containing two clones only. The total number of legitimate families (that is, specific crosses of clone A $\times$ clone B) which may be produced by an isolation garden is not very large when the number of clones included is small, but increases rapidly as the number of clones is increased. In the well-known Tjikadoe garden, for instance, which contained 25 clones when first planted, no less than 300 different crosses were possible, not including reciprocals and selfs. Even when certain of the clones found to be poor parents were cut out and the number was reduced to 17, the possible crosses dropped to 136, still a very considerable number.

Information available on which to base an estimate of the value of isolation garden seed may be of two kinds, namely, yield records of seedlings produced by the garden itself; and yield records of legitimate families representing some of the possible combinations in the garden. Since flowering time and seeding capacity vary in different clones, marked deviation from the ideal equal representation of each possible family is to be expected among

samples gathered at different times. And so it follows that with this class of material, as with illegitimate seedlings, the yields to be expected are more speculative than in the case of budgrafts of a good proved clone. A possible example of this effect is given by two areas of Tjikadoe seedlings in this country, planted in the same year, one of which is giving nearly twice the yield per acre of the other. Admittedly they are in different localities, but growth is quite good in both areas.

The third class of clonal seedlings, legitimate seedlings of the cross clone A by clone B, has not, until relatively recently, been of any commercial significance whatsoever. But when it was demonstrated that certain of these families had sound secondary characters and were capable of yields of the same order as those of the best proved clones a successful attempt was made to adopt the technique of artificial pollination to commercial practice, with the result that hand pollinated seed of a number of legitimate families is now offered for sale in Java, though it is, of course, expensive, and the supply is limited. Apart from artificial pollination, the only way in which legitimate seed of a particular cross can be obtained is from isolation gardens containing the two desired parental clones. A few such duo-clone gardens of seed-bearing age are in existence in the N.E.I.

It may be feared that in addition to seed of the desired cross, these gardens may produce a certain amount of self-fertilized seed, which is known in some clones to give seedlings with very poor growth. Little information is available as to the capacity of different clones to set selfed seed—in the case of TJ. 1 a certain amount is known to be produced and to be capable of yielding very well—but in general, on account of the partial self-sterility of the majority of *Hevea* trees, it may be expected that the proportion of selfed seed produced by duo-clone isolation gardens will be low. Nevertheless, until more information on this point is available, "legitimate" seed from isolation gardens must be classed as less reliable than seed produced by artificial pollination.

The best legitimate families tested so far are as follows :—

TJ. 1 × TJ. 16
TJ. 1 × TJ. 1
Pilmoor B. 84 × Pilmoor A. 44

A.V.R.O.S. 166 × 161
A.V.R.O.S. 157 × 166
PR. 103 (B.R. 2) × PR. 105
PR. 103 (B.R. 2) × PR. 106
PR. 103 (B.R. 2) × PR. 107

Although all these families have done very well in the localities in which they were tested, it should be pointed out that there is no knowledge of their reaction to a wide range of environmental conditions such as there is for the older proved clones. And until such knowledge is available, buddings of these clone will continue to be a safer form of investment.

To return now to the general problem of seedling *versus* budgraft, it appears to me that four points might be advanced in favour of seedlings. Firstly, it is known that ordinary seedling rubber is capable of maintaining at least a fair yield even on third and fourth renewal ; the ability of budded trees to do likewise is still problematical. Secondly, individual clones often suffer from characteristic defects, such as Brown Bast, liability to wind damage, etc., the incidence of which is exaggerated as a consequence of the identical hereditary structure of the clone members. Thirdly, the yielding power of a seedling stand may be increased by planting at a high density and by later selective thinning. Fourthly, seedlings do not suffer from the set-back due to the budding operation and reach maturity earlier.

In answer to the first point, all the older approved clones have now been tapped on renewed bark with satisfactory results. For example, the two original trees of TJ. 1 yielded in 1938 an average of 59·2 lbs. per annum on quarter-cut on first renewal. This is an indication of what may be expected from later renewal, provided it remains strong and even, for which there is evidence. Moreover, any advantage which the seedling might have in this respect is offset by the greater area of tappable bark on the buddings which permits at least a 10-year tapping cycle. At present it seems unlikely that we should want to tap more than second renewal, since on a 10-year cycle this corresponds to an age of about 36 years.

Next, clone defects. These are not to be attributed to the grafting process, rather are they expressions, admittedly undesirable

ones, of the clone's specific hereditary constitution. Legitimate families, whose ranges of hereditary constitution are limited, frequently exhibit similar defects. The TJ.1 × TJ.16 family, for instance, has a fairly high incidence of both Brown Bast and wind damage, while the Pilmoor B. 84 × A. 44 cross produces many individuals with the "knobbly" stem characteristic of the A. 44 parent.

Coming now to the third point, an improved yield certainly should be obtained by planting an increased number of points per acre and subsequent selective thinning, but the percentage gain would not be so great as in the case of a stand of ordinary estate trees, on account of the lower range of yield variation in clonal seedling populations. In this connection the variation in yield within a clone should not be overlooked, for though the range is lower than in any form of clonal seedling material, it is still sufficient to show a real response to dense planting and selective thinning. A further point to bear in mind is whether the return would be sufficient to justify the increased cost of planting.

No argument can be adduced to counter the fourth advantage, that of quicker growth and earlier maturity, but it will not be of much importance over a period of years.

Three of the points cannot then be substantiated, and we have seen that the fourth, though in favour of the seedling, is not likely to be of much significance.

Hence I conclude that at present no case can be made out for the seedling tree as a plant form *intrinsically* superior to the budgraft.

Recommendations for Planting Material in 1940

This year we have followed the current practice in the N.E.I. and divided the approved material into two categories, suitable for large scale planting, and suitable for planting on a limited scale only. The latter class has been sub-divided into two sections comprising clonal and seedling material respectively.

We recommend that individual clones of the first category should be planted up to a limit of 25 per cent. of the total planting programme, except where it is known that a clone is particularly well suited to the locality, in which case the proportion may safely be increased.

The total area to be planted with material of the second category should not exceed 20 per cent. of the whole programme, and it is suggested that not more than 10 per cent. of the total should be allotted to any one clone or seedling family.

There is a third possible class of material comprising promising but insufficiently tested clones, such as those of the new Prang Besar series, which are well worth planting on an experimental scale. Clones of this class might be planted in small duo-clone blocks. The second clone, comprising alternate trees in each row of one of the standard clones approved for large scale planting, is included partly as a standard of comparison and partly so that in the event of the experimental clone proving unsatisfactory it may be removed leaving an economic stand. The initial stand should be 200 to the acre, *i.e.* 100 of each clone. It is further suggested that the second clone should be a medium grower so that there should be no undue competition between the two clones at the high initial planting density.

Noteworthy changes in our list of approved material this year are the inclusion for the first time of certain Ceylon clones and the transference of P.B. 25 to the group for small scale planting.

Recommended for Large Scale Planting :—

TJ. 1	Glenshiel 1
TJ. 16	Pilmoor B. 84
P.B. 86	Millakande 3/2
B.D. 5 (on deep fertile soils only)	

Recommended for Small Scale Planting :—

(*a*) *Clones*

P.B. 25	A.V.R.O.S. 352
P.B. 186	PR. 107
HC. 28	WAR. 4
WG. 6278	Pilmoor D. 65
A.V.R.O.S. 255	

(*b*) *Seedling Material*

TJ. 1 × TJ. 16	Prang Besar I.G.
TJ. 1 × TJ. 1	Tjikadoe I.G.
A.V.R.O.S. 163 illegitimate	

Notes on Material Included

Test tapping results of many of the clones discussed below will be found in the Rubber Research Scheme Quarterly Circular, No. 2 of 1939. Yields of small areas in semi-commercial tapping are given in the appended table. These are taken mainly from tapping experiments, the yields of the $\frac{1}{2}$S,a.d. plots being given. Data of clone A.V.R.O.S. 49, which may be of interest are also included in the table.

Tjirandji 1.—This clone continues to occupy a prominent place amongst the most satisfactory material available in Ceylon. Yield records from a number of districts, not only from test-tapping, but from commercial tapping of appreciable acreages, show its performance to be uniformly good. Wind damage has in some cases been severe in low-lying fertile areas where growth has been rapid, but on exposed hill slopes, where growth has been relatively slow, damage of this kind has not been extensive. The clone is liable to develop a certain amount of Brown Bast when tapped on $\frac{1}{2}$S,a.d., but this can be controlled by changing to a less severe system. A further disadvantage is the late drying of the tapping panels owing to the dense canopy of foliage. For this reason it is recommended that in the wetter districts the clone should mainly be planted on the eastern slopes of hills in order to take advantage of the drying effect of the morning sun.

Tjirandji 16.—This clone also continues to do very well particularly in parts of the drier districts. A characteristic feature of the clone is its strong bark renewal. It is relatively slow growing and on this account its use on poor soil is not advised.

Prang Besar 86.—Not so much is known concerning the performance of this clone in Ceylon. Present indications, though, are that it will do very well. Its growth is moderate and the few trees which are in test tapping are yielding satisfactorily. It is suggested that planting of this clone also should be confined to areas of good soil.

Bodjong Datar 5.—Yield records show that B.D. 5 does quite well on the deep fertile soils found in parts of the drier districts and so we recommend that its use be mainly restricted to such areas. In comparison with other clones it is usually rather late to come into tapping.

TABLE

Yields of monoclone areas in semi-commercial tapping

($\frac{1}{2}$S, a.d.100%)

Clone	Locality	Date planted or budded	Yield per Acre in lbs. for period of		Acreage A/B*	Number of Tappings	Tapped Stand per acre
TJ. 1 ..	Kalutara	1931/32 ..	600	9 months ..	3·2/16 ..	120 ..	125
	Ratnapura	1931/32 ..	422	9 ,, ..	3·6/18 ..	106 ..	111
	Elpitiya	1931 ..	616	12 ,, ..	1·8/5·3 ..	158 ..	112
TJ. 16 ..	Ratnapura	1931/32 ..	349	6 ,, ..	7·0/21 ..	64 ..	114
	Kurunegala..	1931/32 ..	850	9 ,, ..	3·0 ..	127 ..	147
B.D. 5 ..	Kalutara	1931/32 ..	389	9 ,, ..	6·8/20·5 ..	120 ..	105
	Elpitiya	1931 ..	467	12 ,, ..	1·2/3·6 ..	158 ..	106
AVROS. 49	Elpitiya	1931 ..	588	12 ,, ..	1·9/5·8 ..	158 ..	129

* The figure corresponding to A is the actual area tapped on $\frac{1}{2}$S, a.d., while the figure corresponding to B is the total area in tapping, the balance being tapped on other systems. The yield is entirely representative of the whole area.

Glenshiel 1.—The limited test tapping records available from areas in this country indicate that Glenshiel 1 is capable of yielding very well in a favourable situation. It is a slow growing clone, and like TJ. 16 and P.B. 86 it should be planted on good soil. It has been reported from Malaya that on ½ S,a.d. 100 per cent. tapping the cuts may go dry. When the tapping system is changed to 1/3 S,a.d. 67% or ½ S,3d. 67%, the trouble is mitigated without seriously diminishing the yield.

Pilmoor B. 84.—This clone is included entirely on its performance in other countries. But it grows so well in such a wide variety of conditions and on such a range of soil types (some of which are closely similar to Ceylon soils), and further, it is so free from defects, that its use on a large scale in Ceylon is considered to be justified. In particular, it is known to grow vigorously on poor soils and on that account is a most useful addition to the planting material available.

Millakande 3 2.—The recommendation of this clone for large scale planting is based on six years' test tapping history at Nivitigalakele and on Millakande Estate. During this period it has yielded very well and has developed no serious defect. Its growth is strong and it should do well on areas of poor soil in the wetter districts. In the absence of knowledge regarding its performance in the drier districts its use in such localities shoud be restricted to a small scale.

Prang Besar 25.—The performance in Ceylon of P.B. 25, which had formerly been approved for large scale planting on the basis of its record in Malaya, has been very disappointing. It certainly grows very well, even on poor soils, but its yield records both from Nivitigalakele and from estates have been so moderate that its continued use on a large scale can no longer be justified. It is possible that future yield records may show up P.B. 25 in a better light, in which case it may be reinstated with the first choice clones.

Prang Besar 186.—This is another clone formerly recommended for large scale planting. It has a marked tendency to produce swollen leaf scars, which, when they occur in the tapping panel, are liable to be the cause of tapping wounds. In Malaya it has been found that wounding may be frequent and that wound recovery is often bad, so it is only approved for planting where previous

experience of the clone has shown it to be satisfactory. In Ceylon there is reason to hope that wounding will not be so severe as in Malaya, and one year's tapping at Nivitigalakele has given encouraging results. The clone is possibly the highest yielder of the original Prang Besar series.

Hillcroft 28. The original buddings of this clone have now been in tapping for eight years and other blocks have been tapped for at least four years in two other localities. In all three it has grown and yielded very well; the original buddings, for instance, averaged over 20 lbs. per tree in 1938 at the age of 10 years.

The clone has developed a certain amount of Brown Bast in test tapping. What the incidence of the disease may be under commercial conditions it is impossible to say, and it is mainly for this reason that the clone has been placed in the " small scale " list. Apart from Brown Bast the only defect is the spiral fluting of the stem. This is probably more aesthetically displeasing than commercially disadvantageous since it rarely interferes with tapping and the renewed panels appear to be flattening out. The defect is not so marked in some localities.

Wagga 6278.—At Nivitigalakele this clone has been outstanding in respect of growth and yield. It has been in tapping there for four years, but in no other locality; for this reason it is at present only approved for small scale planting. Bark renewal is excellent and branching is not of a type likely to be affected by wind damage.

A.V.R.O.S. 255, *A.V.R.O.S.* 352, *Waringiana* 4, *P.R.* 107, *Pilmoor D.* 65.—These clones are approved for planting in other countries, where they have been shown to be capable of high yields. They are certainly worthy of test, but until something is known of their reaction to Ceylon conditions planting on more than a small scale cannot be recommended.

This list of new imported clones is not intended to be exhaustive but rather to conform with the material which is believed to be available in the Island at the moment. Other clones recommended for planting in the N.E.I. and Malaya which may be imported into Ceylon would also be suitable for small scale planting.

Seedling Families

Apart from the Prang Besar and Tjikadoe I.G. seed the only families of seedling material recommended for use here are those known to be potentially available in Ceylon.

We recommend that seedlings should be planted at least at the rate of 200 points to the acre in order to allow for subsequent thinning.

Since the cost of special seed is high and supplies are usually limited the artificial production of seedling twins might with advantage be tried by estates. Details of the method used will be given upon application to the Research Scheme.

Tjirandji 1 × *Tjirandji* 16 *and Tjirandji* 1 *Selfed.*—Seedling material of these families has yielded very well at the Tjiomas Selection Garden in Java, but a relatively high incidence of Brown Bast has been noted.

Seed of the cross TJ. 1 × TJ. 16 might be obtained from any duo-clone planting or where two monoclone blocks adjoin. TJ. 1 selfed seed could be collected from the middle of a monoclone block at least 20 acres in extent.

A.V.R.O.S. 163 *Illegitimate.*—This family is in test in Sumatra, where, as stated above, it has grown and yielded well. In 1938, for instance, 40 trees yielded an average of 13·4 lbs. per tree at the age of $7\frac{1}{2}$ years. No defects have been recorded and the trees are described as "handsome with good bark renewal." In view of what has been stated above concerning illegitimate seedlings, the use of this material could only be approved if the pollen parents are likely to be buddings of other good clones.

Prang Besar and Tjikadoe Isolation Garden Seed.—As explained above, isolation garden seed is not such a reliable form of planting material as legitimate seed. Nevertheless, seed from these gardens is considered to be suitable for use by those who wish to plant some seedling material and are unable to obtain legitimate seed, or unprepared to pay the extra cost involved.

Seed is offered for sale from three Prang Besar Isolation Gardens, namely, Plots C, D and E, containing 14, 7, and 4 clones respectively. Early tapping results reported from a large scale experiment involving 162 acres show that on a per tree basis seedlings from all three

plots have given yields better than mixed buddings of the three Prang Besar clones 86, 183, and 186, and it remains to be seen whether this advantage will be maintained.

Tjikadoe seedlings are probably not such high yielding material, though commercial tapping records indicate that they are capable of a very satisfactory return. An area of 20 acres in Ceylon, for instance, produced an average of 900 lbs. per acre in its second year of tapping at the age of 10 years.

Seedlings for Use as Stocks

Evidence is accumulating that the potential yield of the stock is positively correlated with the yield of the scion, particularly when the tapping cut approaches the union. In practice this means that by using superior stocks the yield of the scions may be increased. The differences involved are likely to be commercially significant and so the problem of what seed to use is worthy of some consideration.

It has been shown in other countries that illegitimate seedlings of clones A.V.R.O.S. 163, TJ. 1 and B.D. 10 are suitable for this purpose, and also certain others of which seed is unlikely to be obtainable in Ceylon. Our recommendation is that the first mentioned three families should be used, and failing them, well mixed seed gathered from polyclone blocks or close to the adjoining boundaries of adjacent monoclone blocks. Seed collected from the centres of monoclone blocks other than TJ. 1 should not be used. Whatever source is used, the seedlings should be selected for vigour in the nursery in the usual way.

In conclusion I must point out that these recommendations should not be regarded as permanent and unchanging, rather must they reflect the growth of our knowledge and experience and so be in a continuous state of alteration and adjustment, of which a case in point this year is the relegation of P.B. 25 to the small scale list.

Discussion

Mr. G. B. Foote.—Can Dr. Ford tell us in connection with P.B. 25 whether the yields taken were from well-manured and cultivated land or from land of poor quality.

Dr. Ford.—Our most complete records are from a block of 25 trees at Nivitigalakele on soil which is definitely poor. Other areas, I think, are generally representative of the soils in Ceylon.

Mr. E. W. Whitelaw.—It may be that the soil on which Clone P.B. 25 was planted was poorer soil than the rest.

Dr. Ford.—You may be right.

Mr. Murray.—Although this block of P.B. 25 at Nivitigalakele is giving disappointing yields it may be noted that the growth of the trees is not unsatisfactory as judged by the fact that the average girth at nine years old was about 30 inches. Our present records are all of a limited character and are from the same type of land.

Mr. Foote.—Is it perhaps the case that P.B. 25 is a poor starter?

Dr. Ford.—Our records are over a period of four years while other areas have not been in tapping so long. There is no evidence of this clone being a slow starter.

Mr. P. R. May.—I see it stated that yield records show that B.D. 5 does quite well on the deep fertile soils found in parts of the drier districts and a recommendation is made that its use be mainly restricted to such areas. My experience is that B.D. 5 is yielding very well on poor soil on which the old Rubber was very bad.

Dr. Ford.—There are grave difficulties in making and presenting recommendations. At present our information is perhaps not quite so extensive as we wish it to be. We have to make the best generalisations we can. There are exceptions always.

Mr. R. C. L. Notley.—I see it stated by Dr. Ford that among the best legitimate families tested so far is Pilmoor B. 84 by A. 44. I have some 11 acres of this seed. Some are good, some are bad, but the average is poor. In view of this experience I am wondering why it is included as one of the best three legitimate families.

Dr. Ford.—All these legitimate families are included on the basis of yield records obtained from other countries. On pages 147 and 148 we give a list of the best legitimate families tested so far.

Mr. A. H. Healey.—Can you give us any information of the relative yields of the best local clones as compared with Tj. 1?

Dr. Ford.—We have no adequately designed clone trials in tapping at Nivitigalakele such as would enable me to make a definite reply to this question. The yields of the three best local clones at Nivitigalakele, MK. 3/2, WG. 6278 and HC. 28, were 15, 14 and 12 lbs. per tree respectively in their 10th year of age.

In reply to a question regarding the variation in growth rate of Mr. Notley's seedlings, Dr. Ford said it was possible that a certain small amount of selfed seed had been included in the batch and asked Mr. Notley what proportion of his seedlings were bad growers.

Mr. Notley.—They are equally divided.

Dr. Ford.—It is highly unlikely that so many of the seed could have been selfed. The variation must be ascribed to some other cause.

Mr. Murray.—The discussion that has just taken place has been a very stimulating and interesting one though I am disappointed that we did not hear from some protagonist of clonal seed. I have very little to add myself. With regard to Mr. Notley's experience of uneven growth of Pilmoor seed, this experience exactly illustrates our difficulty in recommending the use of seedling families without knowledge of how they will grow under local conditions. It also justifies our contention that if clonal seed is to be used it should be planted at about 200 holes to the acre so that the poorer plants can be removed.

Replying to the question raised by Mr. Healey on the relative yields of the best local clones and Tjirandji 1, I would say that although we cannot make a critical comparison the figures available suggest that the order of yield is approximately the same.

SOME ASPECTS OF BUDGRAFTED RUBBER IN CEYLON

E. W. WHITELAW
(Pantiya Estate)

DURING the year 1939 I had the opportunity of seeing some 6,451 acres, on 54 estates, of budded rubber in Ceylon; some in my capacity as Visiting Agent and some as a special Assessor of budded rubber. In the latter capacity I, therefore, had the fortune to see a good deal of Ceylon's mature budded rubber, and it is mainly in regard to the lessons to be learnt from these areas that I write these notes.

I wish to make it quite plain that the following remarks do not apply to younger areas (*i.e.*, those planted after 1934), but to those now of assessable age, which, as far as Ceylon is concerned, means those generally planted between 1929 and 1933.

I do not wish to be depressing, but there is no doubt that on the whole these areas in Ceylon are most disappointing, although of course, there are exceptions of really good plots of young rubber here and there. Generally, however, a good many of these areas present the very picture an opponent of budgrafting would like to see, and if for instance, I were endeavouring to persuade a Director from London of the possibilities of budded rubber, there are many areas in Ceylon which I would not like him to see. Although I have always been strongly in favour of budded rubber, I often returned from a day's assessing wondering if the often-repeated doubts as to whether it was possible to grow a budgraft into a strong healthy tree were, after all, well founded. Fortunately I could reassure myself by visualising the really fine areas of budded rubber I had seen.

If the reason for my disappointment is sought, my answer is that, barring the few exceptions, there are far too many trees in

every acre which look like never maturing, and seem to be static and permanently stunted. Only in very few cases can those trees which have matured compare in growth with seedling rubber of similar age. I repeat I am referring entirely to Ceylon's older budded rubber.

I would illustrate that these remarks are not based on opinion only, but are supported in fact, by stating that on 29 estates in the best rubber growing districts in Ceylon (Kalutara and Ratnapura) I assessed 204,398 trees all over five years old, and averaging seven to eight years. At this stage one would expect to find at least 70 per cent. to 80 per cent. to be of assessable girth; which is put at the very low limit of 18 inches at 3 feet from the ground.

Of the 204,398 *trees only* 107,967 *or* 53 *per cent. were* 18 *inches in girth.*

(1) The best estate showed 96 *per cent. of assessable trees* and was assessed at 387 lbs. per acre.

(2) The worst estate showed 11 *per cent. of assessable trees* and was assessed at 59 lbs. per acre.

The financial loss, by reason of poor assessment, to No. 2 estate which had not looked after its clearings is great, and is an annually recurring one.

An average of only 53 per cent. of trees over 18 inches at seven to eight years can only be called very disappointing, and on this basis it certainly looks as if we shall not bring our budded rubber into full bearing for nine or ten years, and much of what I saw will never reach proper maturity.

Having given this rather depressing story I now turn to a more optimistic line of argument, and would say that I am convinced that in every single case among the estates quoted there was a reason for the backward growth, and a lesson to be learnt.

I feel sure that if we care to learn these lessons so manifestly illustrated in Ceylon's present mature budded rubber, the errors made by the pioneers are nearly all now avoidable, and we can, by avoiding them, ensure excellent ultimate results in the large areas of rubber land being replanted in Ceylon to-day.

As an illustration of what good budded rubber can be I would quote what is perhaps the best clearing I have seen in Ceylon, or

elsewhere. At exactly four years old the average girth is 16½ inches and some trees measure 22 inches. This clearing has been well cared for from the start, and the growth could not be bettered. It should qualify for the maximum assessment as soon as it reaches assessable age.

In every case of poor growth I endeavoured to ascertain the reason and I put down the irregular and backward growth of these areas mainly to the following:—

(1) *Insufficient general manuring* in the first three years.
(2) *Entire lack of special manuring* of backward plants.
(3) *Use of poor clones*, and clones ill-suited to the soil or local conditions.
(4) *Lack of attention* to ground conditions.
(5) *The use of too heavy a stand of Albizzias.*
(6) *Inefficient and lethargic supplying* of vacancies.
(7) *Poor holing and filling.*
(8) *Suppression by surrounding old rubber.*
(9) *Suppression by continual wind.*

I offer the following short notes under the above headings:—

(1) *Insufficient General Manuring in the First 3 Years.*—It is apparent that the first three years in the life of a budded tree are the most important ones. If it can be made to grow vigorously from the very start and kept in this condition for three years, its success is almost assured. A budgraft seems far more susceptible to poor soil than a seedling, and on no account can manure be deleted or curtailed in its early life. Any attempt to do this, except where soil is naturally rich (and this is not often the case in Ceylon will result in a field of poor stunted backward trees. I do not suggest that manure should be withheld from three years onwards, but I do not think it is as vitally important then as in the earlier years.

(2) *Lack of Special Manuring of Backward Plants.*—In most clearings there is a certain percentage of backward plants. This may be due to poorer pockets of soil; to poorer root systems, or to an inherent defect in the bud and its eventual shoot. It pays well to give such plants extra manure, say every six months, until such time as most of them at any rate are growing vigorously. I

feel sure the secret of an " even " clearing is the continued special manuring of backward plants in the first and second years.

(3) *Use of Poor Clones, and Clones ill-suited to the Soil, etc.*—The pioneers of budgrafting in Ceylon can in no way be blamed for using clones, poor in growth, and perhaps ill-suited to prevailing conditions. Every planter now knows that some clones grow infinitely more vigorously than others, and that some prefer certain types of soil, etc. This is an aspect which requires very careful consideration when a replanting programme is being laid down. Such questions as exposure to wind of clones liable to wind damage, etc., must always be considered. I personally would much prefer a vigorous growing field of medium yielding rubber to a poorly grown one of a clone which is known to yield well only when it grows well.

(4) *Lack of Attention to Ground Conditions.*—By this I refer to improper control of legumes, usually Pueraria and the growing of grass in clearings. Pueraria, if not constantly kept well back from young plants, can literally strangle them and I have seen many cases of this. For the first two years at least Pueraria must always be kept well away from the young plants.

As to grass, this is universally condemned in all rubber countries, and there is no doubt that a mat of it clogs and retards growth.

(5) *The Use of too Heavy a Stand of Albizzias.*—A well-known planter, and a strong advocate of Albizzias recently agreed with me that Albizzias must be " Used with care." I agree that Albizzias are extremely useful as wind breaks on wind-swept ridges, but apart from this I do not favour them.

They are very greedy feeders and I feel sure they often retard the growth of young rubber. If anyone doubts this, let him open up a few rubber holes near an Albizzia tree and see the mass of Albizzia roots which have invaded that hole. Personally I am not keen on Albizzias at all, and it may be coincidence, but the clearing I saw with the most Albizzias in it showed only 22 per cent. of its trees as having reached assessable girth (18 inches) in 1939, although planted in 1930.

(6) *Inefficient and Lethargic Supplying of Vacancies.*—I fear that many of the estates which showed such low percentages of assessable trees must attribute this to unsuccessful or slack supplying of vacancies. This was a common feature in many earlier replantings.

To make a success of a clearing it is essential to go on supplying until every hole carries a successful and vigorous budgraft. The longer the delay the more uneven the clearing will be, and the greater the loss when the clearing is of assessable age. I have seen a 1931 clearing still being supplied in 1939.

(7) *Poor Holing and Filling.*—This is a somewhat moot point, but I am sure cheap filling does not pay. Filling is a work which can be done for anything between 2 cents to 20 cents a hole. In the former case it usually means that coolies merely refill the hole with the material they have just dug out. I consider it essential to collect only the very best soil from drains, rock crevices, etc., so as to give the young plants a good initial start, and this may cost 10 to 15 cents per hole.

(8) *Suppression by Surrounding old Rubber.*—Old rubber most definitely suppresses the growth of adjacent budded rubber. The roots of the old rubber trees invade the holes and the foliage screens off the necessary light. A good many of Ceylon's earlier clearings consist of small 2 and 3-acre patches, and this perhaps accounts in part for the general poor growth I have referred to. I consider it a waste of money to plant up small 2-acre blocks in the middle of old rubber. Only a limited percentage of the trees will ever reach maturity.

I have seen an estate lay out its replanting programme in small areas of this nature, and I think it will be lucky if 50 per cent. of the budded trees ever reach assessable size.

(9) *Suppression by Continual Wind.*—Most estates have a few wind-swept areas where the growth of the old rubber was poor, and it is now quite apparent that this poor growth was due to wind.

Invariably these areas seem to face the South-west which during the Monsoon, especially near the coast, means continuous high winds for five to six months. The short gusts which accompany the North-east Monsoon do not appear to affect the rubber.

I have seen many of these "South-west" patches where old rubber was poor, but where the budded rubber looks like being even worse! The leaves are tattered and torn and the stem is black, bud-bound and static. Generous extra manure does not seem to help much, and the plants only put on growth during the comparatively peaceful North-east Monsoon (October till March).

The remedy is difficult. One or two Gliricidia cuttings planted 7 to 10 feet distant on the South-west side may help to screen off the wind, but generally these areas should be avoided in a replanting programme where possible.

I think budded rubber is more susceptible to wind than seedling rubber, and I would rather have a stand of medium-grown seedlings (preferably clonal) than a stand of utterly useless buddings.

Conclusion

I feel sure that if attention is given to all the above points most estates can look forward to making a real success of their replanting programmes.

Miscellaneous

The following miscellaneous notes may be of interest, even if they only invoke argument and discussion.

Budding in the Field *vs.* Budding in the Nursery

At last year's Rubber Conference, I expressed myself as strongly in favour of budding in the field, but I gathered that the feeling of the meeting was somewhat against me. I am still strongly in favour of budding in the field; chiefly for two reasons, viz.:—

(*a*) I am convinced that budding in the field (when there are two or three healthy stumps per hole to bud on to) gives, under estate conditions, a far quicker 100 per cent. success and consequently a far more even growth. This method is entirely independent of weather conditions.

I cannot illustrate this point better than by quoting the following comparison from adjacent clearings on the same estate, taken in 1938, when dry weather followed planting out and killed off a lot of the nursery buddings.

Field No. 1 Budded in the Field.—Vacancies 38 out of 4,733 or ·80 per cent. (point 8 per cent.).

Field No. 2 Budded in the Nursery and Transplanted.—Vacancies 715 out of 3,284 or 20 per cent.

I would specially recommend field budding in dry districts.

(*b*) *Fomes.*—It will be agreed that Fomes in replanted clearings is a real problem. It often appears where Fomes was never known to exist before.

How much of it is carried to the field from Fomes infected nurseries ?

I think it certain that many of Ceylon's nurseries are infected with Fomes, as very often these nurseries are made in swamp or deniya lands which are very favourable situations for the disease.

During the last two years I have seen Fomes break out in many nurseries, and often it must go undetected. With budding in the field the risk of transplanting the disease on a fairly large scale, is obviated.

I would emphasise that much of the delay caused by waiting for August seed for field budding can be avoided by obtaining seed from Uva in December or January, and by growing it in tea supply baskets while the land is being prepared. Planting out can be done in March or April, and budding about December of the same year.

It is, as a Dutch friend pointed out, a cardinal error to have only one seedling per hole. It is essential to have at least two in each hole, and as Uva seed does not germinate very well, at least four per hole should be ordered.

Elevation at Which to Replant

This is a most important point which calls for further investigation, and the elevation above which it is not safe to replant may vary in different districts.

From what I have seen, however, I would personally hesitate before planting budded rubber above 1,000 feet except under the most favoured circumstances as I have yet to see well-grown budded rubber above this height.

On an estate where the budded rubber started at about 500 feet and rose to well over 1,500 feet, the growth was excellent in the lower areas, but every foot above 700 to 800 feet showed increasing decline in growth and percentages of assessable trees. While most trees at the lower elevation were well grown there were very few assessable trees at the top. I saw this on several estates.

Budded rubber seems even more susceptible to stunting by wind and Oidium than seedling rubber, and I would advise all companies to keep below 800 feet if at all possible. I do not say that the trees will not grow at higher elevations, but I think they will take a far longer time to reach maturity, and other difficulties will be encountered.

Stand per Acre.—In regard to the ultimate stand per acre, there are valuable lessons to be learnt from Ceylon's mature budded rubber. It is quite obvious that the stand per acre can vary with the clones used, and the lie of land.

Anyone who has seen a stand of mature TJ. 1 will agree, I think, that the land will not carry more than 95 to 100 of this heavy crowned clone.

Glenshiel 1, P.B. 25 and P.B. 86 all have lighter or narrower crowns and can easily carry an ultimate stand of 130 to the acre.

To allow for "runts," breakages, diseases, etc., I think 20 per cent. *above* ultimate requirements should be the initial stand to aim at.

I cannot understand the planting of 200 to 250 per acre, as is sometimes recommended in other countries. Such a dense stand will undoubtedly mean high yields per acre while tapping is on virgin bark. I consider, however, that bark renewal will be anything but good, and that there will be heavy decreases in yields per acre when tapping on renewed bark is started.

If an estate can afford a fairly high initial stand per acre, and thin out before the trees finally mature then increased yields per acre will definitely be the result.

Budgrafts *vs.* Clonal Seed

This is a point on which there is so much controversy especially in Malaya, that I do not express any very strong opinion.

There is one thing about the clonal seed areas I have seen in Ceylon (although there are not many) and that is that clonal seedlings seem to grow much more easily than buddings, and do not appear nearly so susceptible to lack of manure or other attention.

From what I have seen of clonal seed, I would expect it to come into bearing 1½ to 2 years earlier than buddings.

I must say I was impressed with the growth of clonal seedlings wherever I saw them in Ceylon, and I personally would now recommend a certain percentage of any replanted acreage to be planted with them if good material is available.

The fact that they will obviously come into bearing a good deal earlier than a budding is an advantage, and the fact remains that they seem much hardier and are less inclined to stunting in situations not wholly ideal for buddings.

The only yield of clonal seed rubber in Ceylon which I have been able to collect is a rather impressive one and is as follows :—

Acres in Tapping ...	20 acres
Total Trees ...	3,036 or 151 per acre
Trees in Tapping ...	2,875 or 143 per acre or 95 per cent. of the total
Planted in	May, 1928
Age	9 to 10 years
System of Tapping	Double Four
Yield	899¾ lbs. per acre in 1938 (without scrap)

I would suggest clonal seed as being more suitable than budgrafts for the small owners' areas now being planted under the New Planting Scheme. I fear many of them will not be able to give budgrafts the attention they obviously require, and that there will be many ultimate disappointments.

Outstanding Clones

This is again a very controversial subject and I am only going to remark on what I have actually seen in Ceylon.

P.R. 107.—This is a fine clone, very popular in Java, of which some 40 buddings are in tapping in Ceylon. The yield, on the day I saw them in tapping, was the best and most uniform I have seen in any country.

In addition to the above, I would pick the following as the best of the well-known clones :—

Pilmoor 84 B.	Glenshiel 1
TJ. 16	TJ. 1
P.B. 86	

P.B. 25 has shown poor yields in Ceylon in its early years, but has a very good record in Malaya.

(There is no Pilmoor 84 B old enough to be in tapping in Ceylon, but it must be included in any list of " Best Clones.")

As regards TJ. 1 I saw many acres of it and in every case the same defect was noticeable.

The tree grows splendidly for six or seven years, but from about the seventh year onwards only the crown shoots up, and puts on fresh foliage and all the under branches die off and become dry twigs. At ten years old a block of TJ. 1 is no longer such an impressive sight, as when it was younger. I think other assessors of budded rubber will confirm this. It is this defect, with the known difficulty of drying for tapping in wet zones, and a liability to Brown Bast which leads me to regard this clone with less favour than it generally receives. It is undoubtedly a first-rate yielder, but with these defects, how long will the yield last ?

Local Clones

I think there are certain Ceylon clones reaching a stage when they will be extensively used instead of imported ones, or at least with them.

Although the yielding capacity of local clones still remains to be conclusively proved, there is no doubt that wherever they are growing, apart from the question of yield, they appear to be generally more vigorous and to carry better foliage and behave in a more normal manner than imported clones. This I attribute to acclimatisation.

I give herewith a list of local clones which recurred on several estates as vigorous and high yielding :—

Millakande 3/2	Wawulagala 120
Hillcroft 55	Wawulagala 320
Hillcroft 28	Heneratgoda 2

I would recommend all estates to lay in small stocks of the above as well as Wagga 6278.

Systems of Opening

I was not impressed with substantial differences in growth due to particular methods of opening the land.

At one time the system of earth works was regarded as a question of utmost importance, but I believe that good filling, liberal manuring and good control of legumes are factors which show results in better growth more than the actual system of opening.

The three main methods in use in Ceylon are :—

(*a*) The Contour or Individual Platform System.

(*b*) The Contour Trench System (to which I give preference)

(*c*) Ordinary Drains and Silt Pits, usually on the Contour with trees on the Contour or " in line."

Roads

A feature of an inspection of Ceylon's budded rubber is that very generally the best clearings are the best roaded ones.

Ease of access is an absolute necessity because the young budded trees require endless individual supervision during the first three years and this is obviously difficult or even well-nigh impossible where there are large areas of unroaded rubber, across which the *Supervisor* has to make slow and difficult progress through a knee deep cover of thick leguminous growth. Every clearing should be well roaded from the start ; preferably with light car roads.

Legumes

Upright Varieties.—My experience of these is that they do well for two years ; especially in the drier districts, but at the end of two years they very generally die off, and leave a legacy of grass which is expensive to remove, and the estate has to then start and establish creeping legumes, after first getting rid of the grass.

Pueraria.—I have always held that although Pueraria perhaps holds back the young plants to begin with, it is the best reconditioner of the old soil *outside* the holes, and that when the roots of the trees reach this soil, growth will go ahead.

I am still firmly convinced of this, and I hope the Rubber Research Scheme, who have a carefully laid out experiment, will soon be able to confirm this theory.

Since these notes were written the following has appeared in the Third and Fourth Circular of the Ceylon Rubber Research Scheme :—

"The differences between the mean girth measurements, corresponding to species of cover, are not significant, but the mean increase of growth of 4·30 inches in 1938/39 in the Pueraria Plots is significantly higher than in other plots. This suggests that Pueraria, which apparently caused the greatest retardation to growth in the first three years on account of its luxuriant development, is now proving to be the most beneficial to the soil."

Pueraria is by far the easiest legume to grow, but it is expensive to control, *and it must be controlled.* Three months growth of uncontrolled Pueraria would give a very serious set-back to young plants in their first year and perhaps kill many of them.

I would say it costs Rs. 12 to Rs. 15 per acre per annum to properly control Pueraria, but, on the other hand, weeding is practically deleted. After the trees are three years old, they are not nearly so susceptible to the encroachments of Pueraria and control may be relaxed.

Note.—Pueraria was thought to be a permanent legume, but quite recently large patches of it in Kalutara and the Kelani Valley have been reported as dying ; due to disease and very often snails.

Desmodium.—On an estate in Kalutara I have seen an excellent semi-erect Desmodium do extremely well, both in the clearings and the old rubber. Snails do not seem to attack it.

It has not been possible to ascertain the variety of this Desmodium and several very contradictory names have been given to it by experts. I would advise estates to buy a bag or two of roots and start it. It can be bought in bags of roots from Eladuwa Estate, Paiyagala.

Albizzias, Dadaps and Gliricidias.—I have already remarked that I do not like Albizzias. I have never seen Gliricidias retard the growth of rubber, and they form excellent wind screens. One of the best blocks of mature rubber (10 years old) that I have seen in Ceylon recently was heavily interplanted with Dadaps for the first four or five years.

Discussion

Mr. H. W. R. Bertrand.—In regard to this question of Albizzia, I rather gather that the area that Mr. Whitelaw referred to contained more Albizzia than Rubber. A reasonable number does an excellent job and helps the young trees, but to swamp a clearing with Albizzia is ridiculous, especially in the early stages. The general concensus of opinion is that they should be planted in the second year. You have to be careful about it. The same remarks apply to other green manures, *e.g.* Crotalaria. You must not plant too many. I agree with Mr. Whitelaw that they are greedy feeders and that there is a tendency to retard the growth of young Rubber, that is why I say they should be used with discretion.

With regard to Clone Hillcroft 28, there is what is called fluting but as the trees grow older this tends to decrease. On the subject of P.B. 25, I would say that I visit an area in which P.B. 25 is in tapping, and of nine clones P.B. 25 occupies eighth position in the list of yields. The clearing is now nine years old.

Mr. J. D. Farquharson.—May I point out that Mr. Bertrand seems to let Mr. Whitelaw off very lightly. I have a ten-acre field containing Albizzias and that field has never been troubled with Oidium. There is another point I want to raise. May I ask what your opinion is with regard to the dynamiting of holes? Do you advise it? In one particular field the trees are growing better than in an adjoining field, but this year this Rubber is suffering more from the drought.

Mr. G. B. Foote.—I was a great supporter of Mr. Bertrand in regard to his advice to grow Albizzias, but I fear I put them down too early and that retarded the growth of the Rubber. There was more Oidium on one block planted with Albizzia. I still believe, however, that Albizzia would be useful if planted in the third year and that it should be lopped.

Mr. Whitelaw.—I think that supports my views. At any rate I am opposed to Albizzia planting. I will admit at once that Albizzias are extremely useful as wind-breaks or on wind-swept ridges, but apart from this I certainly do not favour them. I still hold that opinion in spite of what Mr. Roy Bertrand has to say.

Mr. R. C. L. Notley.—On page 170, you say that Pueraria, which was thought to be a permanent legume, was dying in large patches in Kalutara and the K.V. What is the reason for it ?

Mr. Whitelaw.—In September it started to die off in large patches in the K.V., and on some estates it went out altogether. I think it was a disease of some kind. In the majority of clearings it was found to be due to snails. I mentioned September, and I must say that I have not seen the disease since the dry weather. I think the disease in the old Rubber and even in the young clearings had something to do with the four or five months' continuous wet weather.

Mr. J. C. Mitchell.—To come back to the question of dynamiting, in 1913 I dynamited alternate rows on an estate in the K.V. I defy anybody now to see any difference between the dynamited rows and the others.

Mr. P. R. May.—I agree with you that Fomes in replanted clearings is a real problem. It appears where Fomes was never known to be before. In the later clearings on Dalkeith the timber was left to rot on the surface and we have had far more Fomes than in the earlier clearings where the timber was burned.

Mr. Whitelaw.—That is also my experience.

Mr. M. Atkinson.—On this question of which is the better place to bud, I am certainly in favour of budding in the field. We have heard planters say that whereas they can get 95% successes by budding in the nurseries they get only 30% by budding in the field, but I have not found this to be so.

Mr. Foote.—With regard to the question of die-back of Pueraria, I think a contributory cause may have been eelworm, but 95% of the Pueraria lost in the K.V. was due to drought.

Mr. T. C. A. de Soysa.—At the beginning of his paper, Mr. Whitelaw stated that a large number of places he had seen were disappointing and that the budded Rubber had not done well. He was referring to areas planted in the years 1929-1933. During these years the Rubber industry was going through a very bad period. Large areas

were neglected for want of funds. Most of the clearings were not even weeded and that was a great set-back which had its effect.

Mr. Mitchell.—One of the points you stress is the question of making a success of the original planting. There is another point to be borne in mind which aggravates the Superintendent's difficulties, and that is that Directors suddenly make up their minds with regard to replanting and there is no continuity of policy.

Mr. Murray.—We have listened to a very breezy discussion and have heard contrary views expressed on a number of controversial points. I am reminded of the story of the old theologian who said he was always perfectly open to conviction, but that he would like to meet the person who could convince him.

I have made some notes and I will do my best to comment on some of the points raised. Mr. de Soysa made a very pertinent remark when he said that during the time the Rubber industry was going through a period of low prices most of the older budded clearings were not even weeded, and this must have given the plants a severe set-back. With that I agree, and I would add that some of these earlier clearings suffered not only from lack of funds but lack of interest.

As regards the old controversy of budding in the field *versus* budding in the nursery, I consider that in the drier districts budding in the field is a safer proposition. On the other hand, when replanting during the S.W. monsoon in districts where a wet season can be relied on, the use of budded stumps will be very successful if it is done properly, and has substantial advantages.

On the question of the maximum elevation suitable for replanting I think it is a mistake to lay too great emphasis on the number of feet above sea-level. There are areas at 1,200 feet elevation where soil conditions are favourable and where I would replant with more confidence than on other land at 800 feet.

On the subject of clonal seeds, Mr. Whitelaw has quoted some interesting figures in his paper. In order to illustrate the rather uncertain results with this type of material, I might mention a block planted with seed from the same source and in the same year

as that quoted by Mr. Whitelaw from which the yield has so far not exceeded 450 lbs.* per acre despite the fact that the trees are well grown. It is possible that the seed planted in one of these areas was early seed, whereas the other was later seed resulting from different crosses.

Experiments in dynamiting are being conducted in Malaya, and the early results show increased growth due to the treatment. I have investigated the death of covers of Pueraria in the K.V. and have concluded that although there are various contributory causes, including eelworm and drought, the main factor is what is known as "soil sickness." The cause of this condition is not clearly known and this is not the occasion to discuss the various theories advanced.

* It has since been ascertained that this yield was obtained on ½S, 3.d. 67% tapping

TAPPING YOUNG BUDDED TREES

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Introduction

THE various operations of planting and replanting, with which earlier papers have dealt, culminate in the tapping of the trees, and it is fitting that this subject should receive consideration at the end of the day's proceedings. I propose to deal only with the tapping of budded trees since the majority of clearings planted in recent years consist of this form of material : moreover, the tapping of young seedlings does not present any special features with which the Estate Superintendent is unfamiliar.

The title of this paper is a short one, and, like most short things, needs explanation. It is not my intention to deal, except incidentally, with the *results* of tapping budded trees, but rather to afford guidance on the *technique* employed for the benefit of those who may be opening up budded areas in the near future. The recommendations contained in the following notes are made with the reservation that many aspects of tapping budded trees are at present the subject of experimental enquiry.

When Should Tapping be Started ?

The first matter for consideration is at what stage in the development of the trees tapping should be started. There is, I think, a general belief that tapping young trees retards their growth and that the longer the trees can be left to mature without disturbance by tapping the better will be their performance in the long run. Although we have no critical data on the subject there is some reason to doubt the validity of this assumption.

A comparison has been made at Nivitigalakele between trees of eight clones which were brought into tapping at an age of six years and an average girth of 19½ inches, and an approximately similar number of trees of the same clones which were not tapped until they were nearly eight years old and had an average girth of 26 inches. During the two years in which the first group was tapped the difference in mean girth increase between the two groups was less than 4 per cent. in favour of the untapped trees. The system of tapping was a half spiral on alternate days with a rest for four weeks covering refoliation after the annual winter, and the conclusion that tapping does not materially retard growth might not apply to other systems.

When the yield records of these two groups are studied it is found that the second group gave in its eighth year of age and first year of tapping approximately the same average yield per tree as the first group in its seventh year of age and second year of tapping. Unfortunately the yields are not strictly comparable owing to the presence of a few later supplies in the second group, but it seems clear that budded trees have to be "educated" to a yield response and that, other things being equal, a tree which has been tapped previously will give a higher yield than one which has not. An experiment has recently been started to shed further light on this point.

The conclusion is therefore reached that, after taking economic factors such as the exportable quota and the price of the commodity into consideration, young budded clearings should see the knife as early as possible. The criterion suggested is a girth of 20 inches at a height of 3 ft. from the union, and a field should be taken into tapping as soon as 75 per cent. of the trees have attained this size. Our experience shows that no harm results from tapping trees with a girth of only 18 inches, and there would be no objection to including trees down to this size in order to round off tapping tasks and increase the proportion of tappable trees to about 90 per cent.

General Considerations in Tapping Budded Trees

There are two outstanding anatomical differences between the stems of buddings and seedlings which affect tapping procedure.

(1) *Relation Between Height of Cut and Yield.*—With budded trees the taper characteristic of the lower part of the seedling stem is almost absent, with the result that the girth, thickness of bark and number of latex vessel rows do not decrease with increasing height to nearly the same extent as with seedlings. The practical significance of this difference is that budded trees may be tapped higher without so great a loss in crop.

The difference is well borne out by the figures given in Table I, for permission to reproduce which I am indebted to the Director, Rubber Research Institute of Malaya. Whereas with seedling trees the average decrease in yield for every inch the height of the tapping cut is raised is approximately 1·4 per cent., with budded trees the corresponding figure is only about 0·5 per cent. On seedlings the rate of decrease is greatest near the base of the panel, but on buddings near the centre of the panel.

TABLE I

Relation between Yield and Height of Cut

Series	Mean Height of Cut	Yield as per cent. of Series 1	
		Seedlings	Buddings
1	15 inches	100	100
2	25 ,,	79	98
3	35 ,,	67	89
4	45 ,,	59	84

These figures are derived from the mean of five clones and there is a certain amount of evidence that clones vary in their responses to tapping height.

When the cut is close to the union the yield may actually show a decrease though here, again, clones differ in their reaction and, furthermore, the yield potentiality of the individual stock is of importance. It is usual to stop tapping within a short distance of the union, partly on account of the decrease in yield and partly because Brown Bast is more likely to develop when the extraction of latex takes place across the imperfectly joined tissues of scion

and stock. It is suggested in a later section that the cut should not approach nearer than 6 inches to the union, but this may be found to be an unnecessarily large margin for some clones.

(2) *Absence of Corky Layer.*—The second anatomical difference is that with rare exceptions the budded tree does not possess the heavy cork layer characteristic of the bark of the basal portion of the seedling stem. This layer contributes nothing to the yield, but provides extra depth for the tapping knife, and is useful for knocking in spouts, etc. The tapper who is used to seedlings may at first find some difficulty in tapping buddings, but after he has accustomed himself to the thinner bark he should be able to do excellent work, especially in a monoclonal block where the bark of every tree is of similar thickness and consistency.

The suitability of tapping implements must also be considered in relation to these two anatomical features.

Tapping Knife.—The Michie-Golledge knife can only be worked easily up to a certain height which depends on the stature of the operator. Up to 36 inches, which is the height we recommend opening panels on the half spiral alternate day system, all but the shortest tapper can use this knife successfully except possibly on the lower side of the tree on very steep slopes or where the tree has been budded rather high. If it becomes necessary to tap much higher, however, a draw knife has obvious advantages. At Nivitigalakele we have trained two Sinhalese men in the use of the Jebong knife. They are doing excellent work but cannot keep to the normal rate of bark consumption of half inch per month.

Spouts and Cup-hangers.—The absence of the outer corky layer leads to the consideration of suitable spouts and cup-hangers.

The dual purpose spout-cum-cup-hanger is unsuitable for use on young budded trees because it cannot be anchored sufficiently firmly to bear the weight of a cup full of latex without being knocked into the wood and thereby causing a wound. Spouts should be of the lightest possible material and made in such a way that they cannot be knocked more than four millimetres into the bark. Various devices have been seen on estates with this object in view. At Nivitigalakele we make our spouts of 24-gauge metal and cut two small tongues which prevent them being knocked in too far.

A suitable cup-hanger can be made of 12-gauge wire and fastened round the tree with a length of thinner wire (16 gauge), a portion of which is coiled in a spiral to allow for the increasing girth.

Tapping System

The choice of the most suitable tapping system is complicated by the fact that not only is it partly dependent on the locality, but also on the clone. There is abundant evidence from small scale experiments that clones respond differently to the various standard methods of tapping, but we have no clear understanding of why this is so nor can we yet ascribe to each clone the system most suited to it. Certain interesting facts are, however, coming to light, largely as the result of work carried out by the Rubber Research Institute of Malaya, and the following examples are quoted mostly from that Institute's Annual Report for 1938.

It appears that Clones A.V.R.O.S. 49, 50, 152 and S.R. 9, all of which are now regarded as rather moderate yielders, may safely be tapped continuously on a half spiral on alternate days ($\frac{1}{2}$, a.d.) and that the trees show little benefit from a milder system. Clone P.B. 25, which is included in the same series of trials, has also given very satisfactory results on $\frac{1}{2}$, a.d. for the first five years of tapping, but the proportion of trees which had gone dry from Brown Bast was 7·8 per cent. in the middle of the fifth year, and this will want careful watching.

In Malaya Glenshiel 1 is better tapped on a half spiral once in three days ($\frac{1}{2}$, 3d.) or a third spiral on alternate days (1/3, a.d.) than on $\frac{1}{2}$, a.d. owing to the development of dry areas on the tapping cuts with the latter system. Experience in Ceylon, however, shows that on either of these milder systems the latex tends to pre-coagulate in the cup, at least in the first few months of tapping. This may be associated with more humid atmospheric conditions in the early morning and may not apply to the drier districts.

Some clones, *e.g.*, A.V.R.O.S. 50, B.D. 10 and Ct. 88, react favourably to fourth daily tapping over the full circumference (1/1, 4d) while others, notably A.V.R.O.S. 256, give a lower yield than on $\frac{1}{2}$, a.d. which is of the same intensity.

Some clones, *e.g.*, A.V.R.O.S. 152 and 256, give a higher yield on daily tapping in alternate months ($\frac{1}{2}$, d. 1/1m) than on $\frac{1}{2}$, a.d. which is of the same intensity, but the reverse appears to be the case for B.D. 5 and P.B. 186. Trees of Pilmoor B. 84 gave a higher yield on $\frac{1}{2}$, d.1/1m. than on $\frac{1}{2}$, a.d. for the first seven years of tapping, but this appears to have been at the expense of growth and more recent yields show the opposite trend.

Experiments in Ceylon.—With the object of obtaining information on the best method of tapping the more important clones of which large areas will be reaching tappable age in Ceylon during the next few years, four experiments were started on estates in 1939, and their number will be increased as suitable areas become available. The period of tapping is as yet too short for definite conclusions to be formed, but the results are worth presenting in this paper and are given in Table II.

The abbreviations used for the several tapping systems are according to the recent Standard International Notation described in Quarterly Circular, Vol. 16, Parts 3 and 4. Since readers may not yet be fully acquainted with the notation the systems are given in full below:—

1. Half spiral on alternate days ($\frac{1}{2}$S, a.d. 100%).
2. One-third spiral on alternate days (1/3S, a.d. 67%).
3. Half spiral once in three days ($\frac{1}{2}$S, 3d. 67%).
4. Double-four, *i.e.*, two half spiral cuts on opposite sides of the tree tapped once in four days (2/2S, 4d. 100%).
5. Full spiral once in four days (1/1S, 4d. 100%).

Experiments 1, 2 and 3 are all of the same type. The unit plot is a tapper's task of 200 trees (a double task in the case of Systems 4 and 5) and the lay-out is in four randomised blocks. In Experiment No. 1 two blocks are on one estate and two on another. In the case of Experiment No. 4 the number of trees available was insufficient to obtain replication within each clone so the comparisons are of a single-plot nature.

An interesting feature of these results is that the yield on 1/3, a.d. is appreciably higher than on $\frac{1}{2}$, 3d. though the intensity of both is

TABLE

Tapping Experiments with Budded Trees. Yield in lb. per acre (total rubber) for period stated and percentage comparison with ½S, a.d. (Figures in brackets denote number of tappings).

Expt. No.	Clone	Locality	Year budded or planted	Acres	Period of tapping	1 ½S, a.d.100% Yield lb. per acre	1 ½S, a.d.100% Yield per cent.	2 1/3S, a.d.67% Yield lb. per acre	2 1/3S, a.d.67% Yield per cent.	3 ½S, 3d.67% Yield lb. per acre	3 ½S, 3d.67% Yield per cent.	4 2/2S, 4d.100% Yield lb. per acre	4 2/2S, 4d.100% Yield per cent.	5 1/1S, 4d.100% Yield lb. per acre	5 1/1S, 4d.100% Yield per cent.
Initial Height of Cut/s (Inches)						34		24		26½		39 & 21½		21½	
1	TJ. 1	Kalutara and Ratnapura	1931/32	34	9 mths.	506 (113)	100	448 (113)	89	414 (77)	82	510 (56)	101	499 (56)	99
2	B.D. 5	Kalutara	1931/32	20½	9 „	389 (120)	100					380 (60)	97	394 (60)	101
3	TJ. 16	Ratnapura	1931/32	21	6 „	349 (64)	100					348 (32)	100	345 (32)	99
4	TJ. 1	Elpitiya	1931	5·3	12 „	616 (158)	100	514 (157)	83	443 (104)	72				
	AVROS 49			5·8		588 (156)	100	499 (156)	85	356 (104)	61				
	B.D. 5			3·6		467 (158)	100	375 (157)	80	305 (103)	65				

Notes (1) The yields refer in all cases to the first year (or portion thereof) of tapping.
(2) The acreages given are divided equally among the systems of tapping under trial.
(3) The initial heights of cuts in Expt. No. 4 were slightly in excess of those given.

the same. The latter, however, is on the increase. Both systems are favoured as regards height of the cut in comparison with ½, a. d., reference to Table I showing that the advantage may be of the order of 10 per cent. The initial heights of the cuts were arranged for a ten-year tapping cycle, one of the advantages of a mild system being that the cut can be kept on the most productive area of bark.

There is no evidence of any substantial difference in yield between Systems 1, 4 and 5, all of which are of equal intensity. In the first one or two months System 1 gave the higher yield owing to the quicker wound response of newly-tapped trees to the more frequent incisions, but latterly there has been the opposite tendency. Observations on the incidence of Brown Bast show that more trees have been affected on Systems 1, 4 and 5 than with the milder treatment of Systems 2 and 3, but in no case is the proportion yet of serious consequence.

The evidence from these experiments up to the present is insufficient to warrant any departure from the standard method of tapping on a half spiral on alternate days. With the knowledge from other sources, however, that Tjirandji 1 is liable to develop a somewhat high incidence of Brown Bast on this system, it may be advisable to adopt either 1/3 a.d. or ½, 3d. with this clone. If the stand per acre at the commencement of tapping is fairly high, viz., more than 120 to the acre, the soundest plan may be to tap on ½, a.d. for one or two years, remove any trees which go dry from Brown Bast, and then revert to one of the milder systems. For the choice between 1/3, a.d. and ½, 3d. we must be guided by future experimental results. Other things being equal the latter is to be preferred as giving cheaper tapping, but in polyclone plantings where the other clones are best tapped on alternate days the third spiral is the obvious choice.

The figures given in Table II are also of interest as affording an indication of the yields which may be expected from budded areas in the first year of tapping. None of the areas in question was manured from the commencement according to modern ideas and more recent clearings may be expected to do better.

Bark Consumption

An experiment was started at Nivitigalakele in April, 1938, to shed light on the optimum rate of bark consumption for maximum crop when tapping young budded trees on the half spiral alternate day system. Eight Ceylon clones are used for the experiment, four trees of each clone being subjected to each treatment. The experiment was planned to run for two years, differences in height of cut being equalised by inter-changing the trees in Treatments 1 and 3 after one year.

The experiment has not quite been completed at the time of preparing this paper, but the results for the first 21 months are given in Table III.

TABLE III

Bark Consumption Experiment

Treatment	Consumption per month	Approx. Number of Shavings per inch	Yield as per cent. of Treatment 1
1	½ inch	25	100·0
2	¾ „	16·7	95·6
3	1 „	12·5	101·4

The treatment effect is not significant, so it would appear that there is no advantage in a higher rate of consumption than corresponds to 25 cuts to the inch. At the same time there is always some doubt as to whether the results of a small-scale experiment of this nature are entirely applicable to commercial estate work for in practice the standard of tapping might not be so uniformly high. The more regular the thickness of the shaving the thinner need it be to obtain the maximum flow. Owing to the greater height at which budded trees can be tapped without much loss in yield there is no great objection to consuming up to 8 or 9 inches a year if difficulty is found in keeping to the lower figure.

Height of Cut

The initial heights of the tapping cut/s suggested below are based on the following assumptions :—

(1) The consumption of bark to be :—

6 inches per annum for alternate day tapping.
$4\frac{1}{2}$ „ „ three „
$3\frac{1}{2}$ „ „ four „

(2) The tapping cycle to be ten years.

(3) The lower six inches of bark to be left untapped as explained in an earlier section.

All heights are measured from the lower end of the cut to the union.

Tapping System	*Initial Height of Cut/s*
$\frac{1}{2}$S, a.d.	36 inches
1/3S, a.d.	26 „
$\frac{1}{2}$S, 3d.	$28\frac{1}{2}$ „
2/2S, 4d.	41 & $23\frac{1}{2}$ „
1/1S, 4d.	$23\frac{1}{2}$ „

These figures need not be regarded as rigid recommendations for all the three above postulates are elastic. For instance, it is not essential to allow ten years before tapping renewed bark. Bark of only six years renewal has been tapped satisfactorily on budded trees in Ceylon and for first renewal, at least, eight years is ample. At the same time there seems to be no advantage in increasing the rate of consumption, and it is considered desirable to open the panels at the maximum height at which tapping is probable in the future.

Slope of Cut

The slope of the cut should be at least 25°. In Malaya and the N.E.I. a slope of 30° is commonly adopted on budded trees, but in our experience 25° is sufficient.

The reasons for having a steeper cut on buddings than seedlings are two-fold :—

(1) The thinner bark of budded trees gives a narrower channel for the flow of latex, and there is a greater tendency for the latex to overflow down the stem if the cut is too flat.

(2) The objection to steep cuts on seedling trees, *i.e.*, that the triangle of wasted high-yielding bark at the base of the tree is thereby increased in size, is of no consequence with buddings as the lowest bark is of no special value.

Change-Over

Controlled experiments on seedling trees have failed to reveal the benefits claimed for the Ceylon practice of an annual or six-monthly change of panels such as better bark renewal and higher dry rubber content, and there is no reason to suppose that the results would be different with budded trees. There is, however, the advantage that tappable bark is available on both sides of the tree if a change from a single to a double-cut system seems desirable at a later stage, and for this reason we do not discourage an annual change-over. If this practice is favoured the second panel on the opposite side should be opened at a height of 21 inches (on $\frac{1}{2}$S, a.d.) so as to maintain a constant maximum difference in level between the two cuts.

Miscellaneous

During recent tapping of budded areas three problems have come to light which may briefly be considered here.

Pre-coagulation of Latex.—When young trees are first tapped trouble is often experienced with pre-coagulation of the latex in the cup or collecting bucket. This usually rights itself after a month or two, but with some clones, notably A.V.R.O.S. 49 and sometimes Tjirandji 1, the tendency persists and the use of an anti-coagulant is necessary. Ammonia and sodium sulphite are the most suitable chemicals for this purpose.

Ammonia.—The stock solution is 1 lb. strong ammonia (25 per cent.) to 8 gallons of water and is used in the proportion of 2 fluid oz. per lb. of rubber.

Sodium Sulphite.—The stock solution is 1 lb. of powdered sodium sulphite to 8 gallons of water and is used at the rate of 1-2 fluid oz. per lb. of rubber. This chemical has the undesirable effect of retarding the rate of drying of smoked sheet.

For addition to latex in the bucket the procedure is simple and merely needs an estimation of the quantity of rubber present. If the anti-coagulant has to be added to the cups it should be contained in a bottle provided with a cork with two small holes, and on tapping a few drops are shaken into the cup.

Transport of Latex.—The dry rubber content of the latex from young budded trees is found to be very low, particularly with certain clones, and the combination of this factor with that of high yields necessitates the handling of large volumes of liquid latex. For example, in the first year of tapping an area of Tjirandji 1 a single tapper's intake from a task of 200 trees has sometimes been as high as 80 lb. (about 8 gallons). With the normal increase in yield that is to be expected as the trees mature this figure may be greatly exceeded, though the increase will be partially off-set by a higher dry rubber content. The inference is obvious : clearings should be so roaded that no tapper has to carry his latex an undue distance to a collecting station or cart road.

Drying of Tapping Cuts.—At the age at which budded areas are taken into tapping the overhead canopy is usually much denser than seedling areas at the same stage, and this is particularly marked with clones such as Tjirandji 1 which carry a very heavy foliage. The consequence is that in wet periods the cuts are very slow to dry and tapping is often delayed until an hour or two later than in neighbouring fields of seedling trees. Moreover, the upright branching habit of many clones, *e.g.*, Tjirandji 1, Prang Besar 25, Millakande 3/2, leads much of the water down the main stem which might otherwise drip from, or dry on, the branches.

Up to the present no really effective means of overcoming this trouble has been devised, though it can be mitigated by pruning low branches and by confining clones with a very heavy head to the East side of hills where the trees receive the maximum drying influence of the morning sun. It is possible that inverted V cuts above the tapping panel may deflect some of the water running down the trunk and thus lead to quicker drying, and we propose to try this out in the near future. If I may conclude on a prophetic note, it is to the effect that a small fortune awaits anyone who can perfect a cheap device for surmounting this difficulty.

Discussion

Mr. A. H. Healey.—Can Mr. Murray give us some information in regard to the question of variability within a clone ?

Mr. Murray.—I can only answer that question by giving the statistic known as the " coefficient of variation." For trees of a single clone the figure is about 20% whereas for a mixed population of seedlings it is about 60%.

Mr. E. W. Whitelaw.—When you speak about variability do you refer to the yield per tree or the yield per foot of tapping cut ? If you refer to the yield per tree I have experience of 100% variation.

Mr. Murray.—I am referring to the yield per tree. A coefficient of 20% does not mean that this is the maximum variation between any two trees.

Mr. Whitelaw.—Can you tell us laymen what this " coefficient of variation " means ?

Mr. Murray.—It is difficult to answer the question without employing statistical terms. The " coefficient of variation " is the " standard deviation " expressed as a percentage of the " mean."

Mr. H. W. R. Bertrand.—I think you will remember that when we started tapping our seedling Rubber there was a great deal of Brown Bast if the trees were opened when very young. Arising out of Mr. Murray's paper, I would like to know whether anything is known of the relative incidence of Brown Bast attacking trees on which the tapping is commenced at different ages.

Mr. Murray.—We have no data at present, but have recently started an experiment which should shed light on this point. On our Experiment Station we started tapping trees of 18 ins. girth and the trees have come to no harm nor is there any undue proportion of Brown Bast. In the tapping experiments which I mentioned in my paper the criterion of girth is taken as a minimum of 18 ins. and so far there has been no undue percentage of Brown Bast.

Mr. P. R. May.—With regard to the initial heights of tapping recommended, may I enquire whether these measurements are taken from the lower end of the cut to the union? If so, the upper end will be over 40 inches from the union and it seems to me that this will be too high for some tappers.

Mr. Murray.—I favour opening the panels at the greatest height at which they are likely to be tapped in the future. The figures I have given in my paper, however, need not be regarded as rigid recommendations to be strictly adhered to. I may also say that it is not essential to allow ten years before tapping renewed bark. Bark of only six years renewal has been tapped satisfactorily on budded trees in Ceylon and my opinion is that for first renewal, at least, eight years is ample.

Mr. May.—You consume more bark with high cuts.

Mr. Murray.—That is quite possible if the tapper finds difficulty in reaching the height.

Mr. May.—Can you tell us something with regard to the question of bark consumption in this connection? It will be interesting to have your views.

Mr. Murray.—I have dealt with this subject in my paper. In April, 1938, an experiment was started at Nivitigalakele in order to get information with regard to the optimum rate of bark consumption for maximum crop when tapping young budded trees on the half spiral alternate day system. Eight clones were used. The experiment was planned to run for two years, and I cannot just now give full results, but on page 183 you will find the results for the first 21 months.

Mr. E. C. K. Minor.—You say that with a draw-knife it may be possible to tap trees when they are too wet to be tapped with the Michie Golledge. Would this not introduce the danger of Bark Rot?

Mr. Murray.—Undoubtedly if adequate control measures are not taken. There should be no great danger if the panels are correctly treated with disinfectant.

CONCLUSION OF CONFERENCE

Mr. P. B. Cruickshank said that before they left he would like to take the opportunity of thanking those who had contributed to the organisation of the conference. He would like, in the first instance, to thank his Committee whose constant assistance and advice had been most valuable. Secondly, he thanked the authors of the papers. He felt that the lively discussions that ensued in each case were an adequate tribute to their excellence. In particular he wished to thank the members of the C.E.P.A., and the members of the Board of the Rubber Research Scheme whose help had been not only enthusiastic but also financial. His thanks were also due to the management of the Grand Oriental Hotel for the excellent arrangement made, and to Messrs. Miller & Co. for the loud speakers. Finally, he thanked all those who took part in the discussion, for without their presence the success of the conference would not have been possible. He then called upon Mr. R. C. Scott, the Chairman of the Planters' Association of Ceylon, to wind up the conference.

Mr. R. C. Scott.—It is my duty to thank the Chairman and the Committee for inviting us here to-day—not only myself but several distinguished visitors—and for the excellent entertainment (if I may use the word) they have given us. Unfortunately I was unable to attend the original Rubber Conference which was organised and paid for by the Kalutara Planters' Association last year. I consider that it is largely due to that Association that enthusiasm has been engendered for holding of such conferences.

I am delighted to see such a tremendous concourse present here to-day. I think it is excellent that you should have sat through five hours of this conference—especially during the difficult and trying hours after lunch.

There are in this room quite a large number of well-known Rubber planters, who have not taken part in the discussions, whose

knowledge of Rubber is very considerable. We have listened with much interest to Messrs. Roy Bertrand and E. W. Whitelaw, both well-known Rubber planters.

There is still much to be learnt about Rubber which can only be done by research and the holding of conferences where views can be exchanged. For instance, it appeared to me that there are still differences of opinion as to how clearings should be felled and the planting methods to be adopted. I also see it stated somewhere that little is known of latex. That goes to show that a great deal of research is necessary.

In this connection I would, with all the earnestness I can command, ask Superintendents to co-operate with the Rubber Research Scheme to the fullest extent.

It was mentioned by Mr. D. S. Senanayake, the Minister for Agriculture and Lands, how necessary it is to pool our knowledge.

The figures given at the beginning of the meeting by the Chairman show that Ceylon is very backward in the race. We have only six per cent. budded Rubber as against 30% in Java; it is very necessary that we should produce rubber at prices that are at least competitive.

In conclusion I wish to endorse the remarks made by your Chairman as regards the arrangements made for the conference. It is a matter of considerable gratification to me that this conference has been held under the aegis of the Planters' Association of Ceylon.

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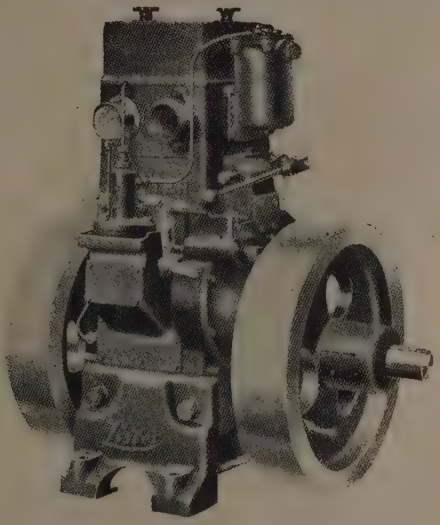

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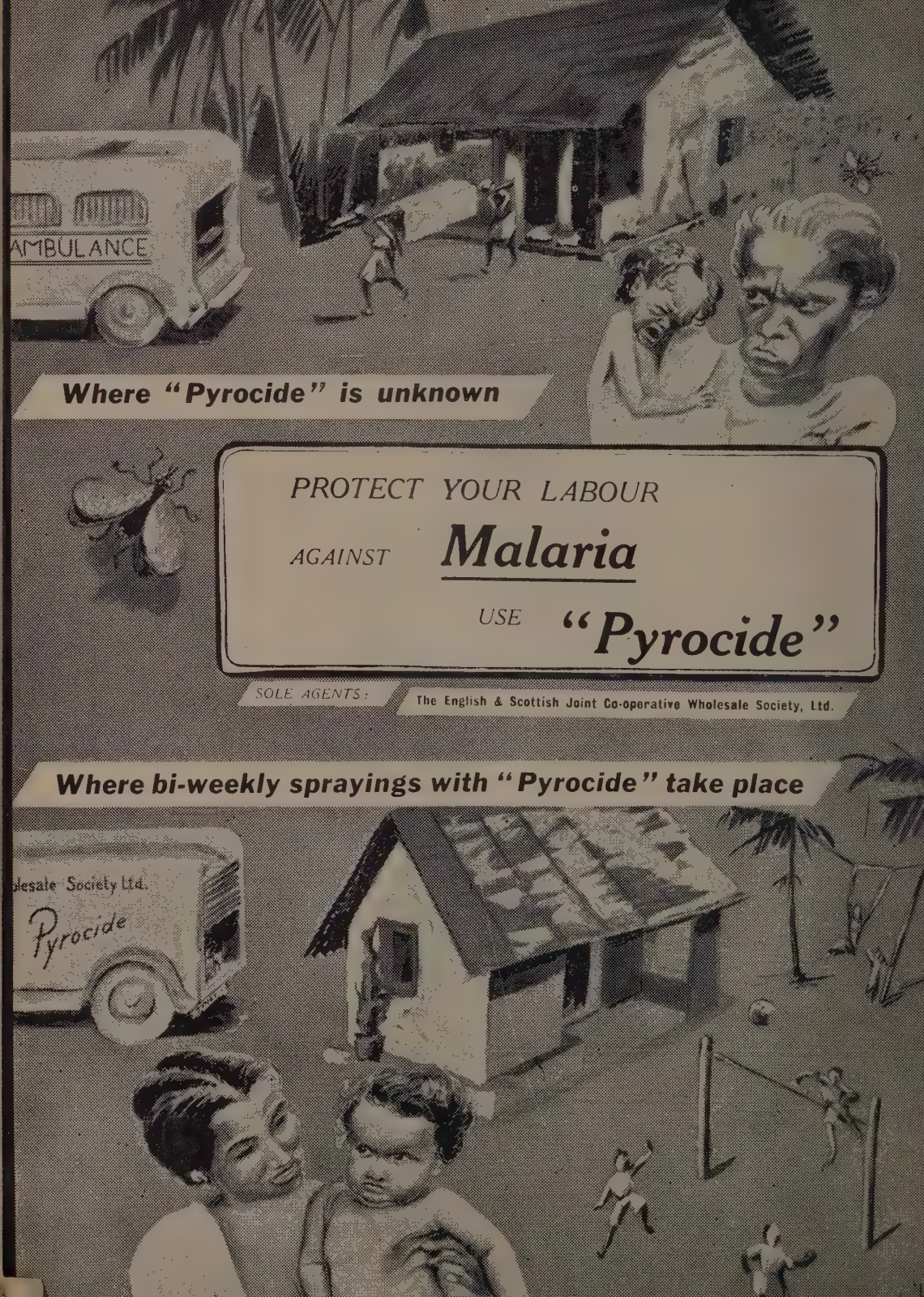
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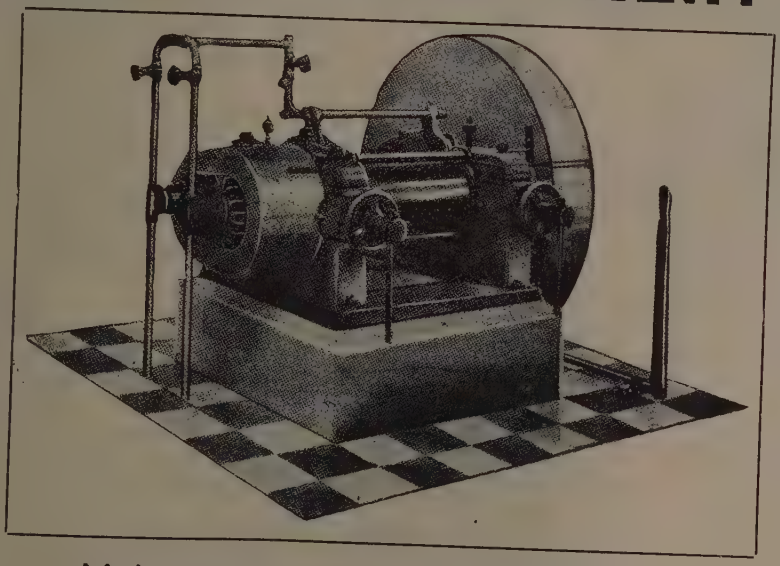

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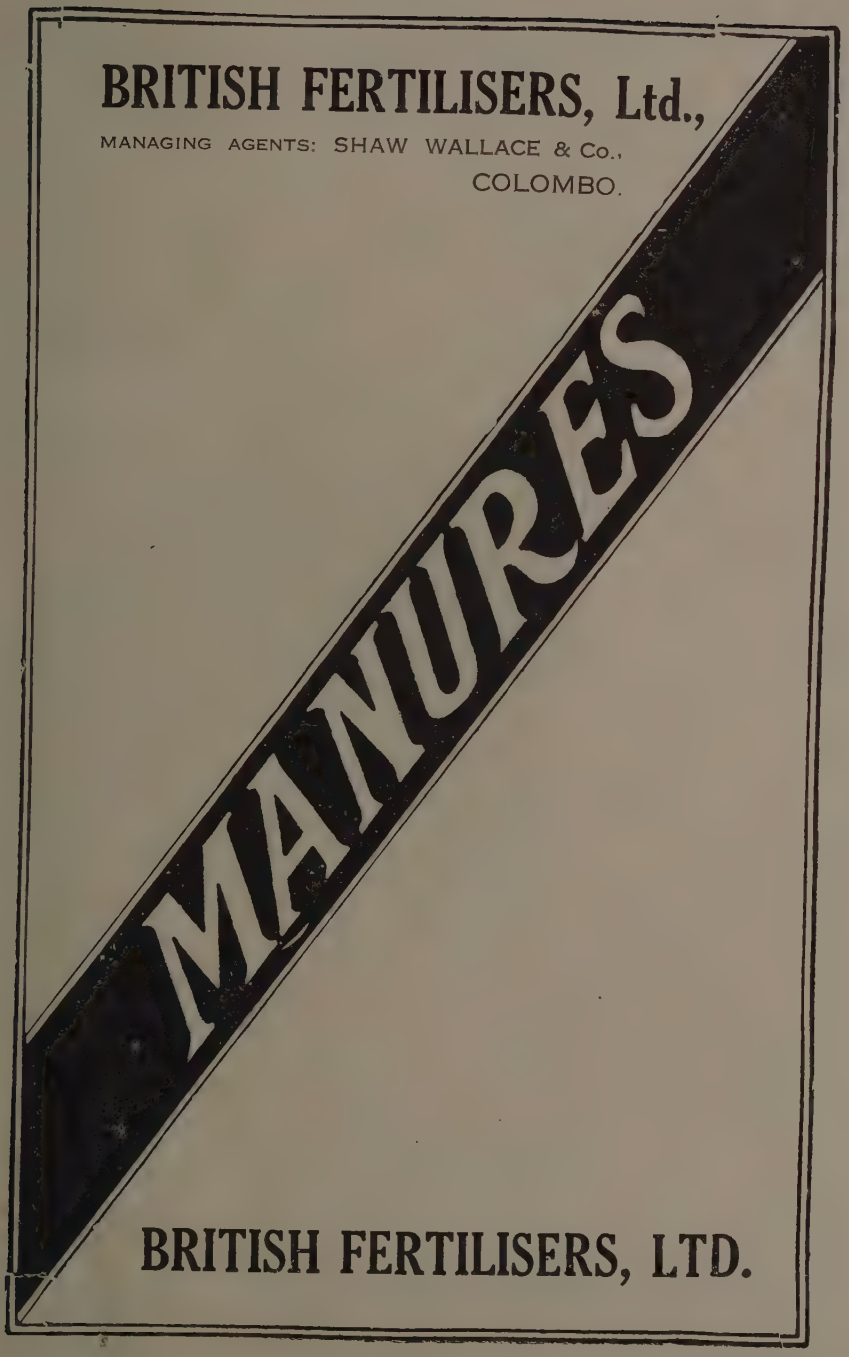
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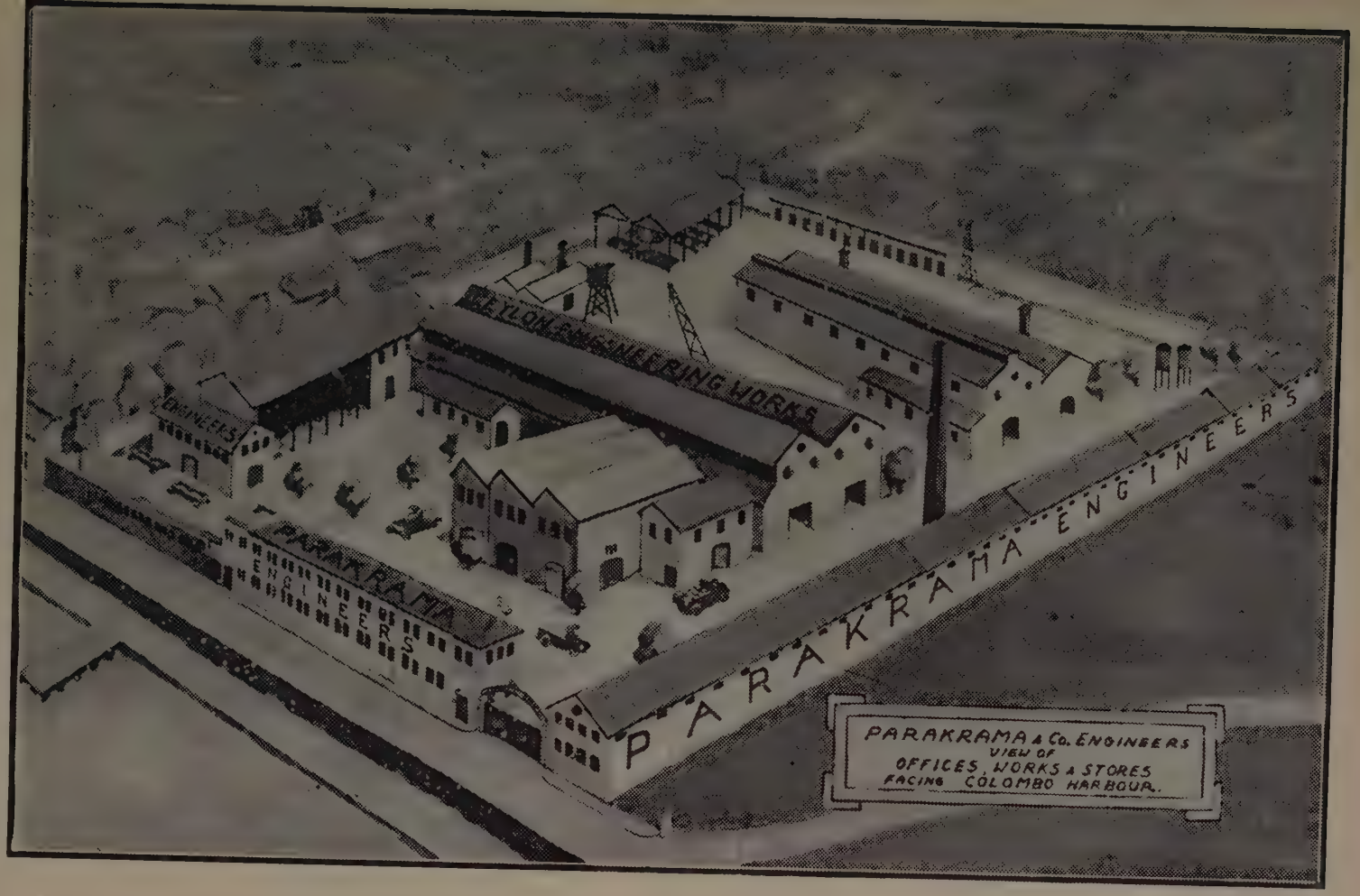
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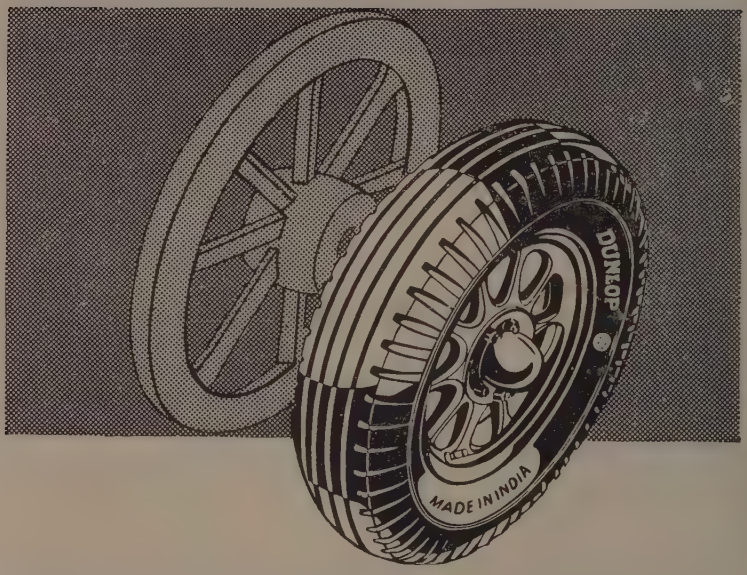

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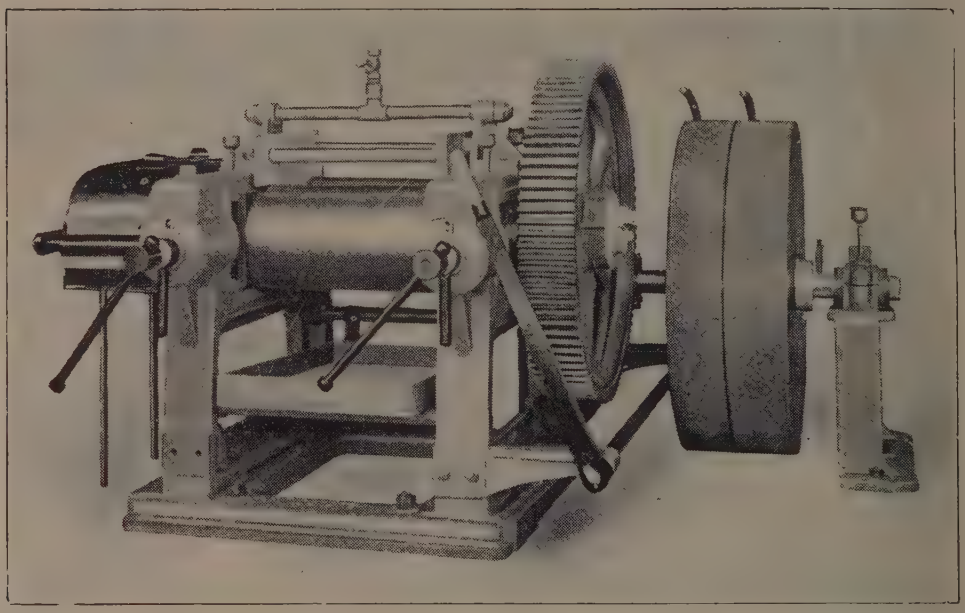

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